Sources of Growth in Latin America

What Is Missing?

Eduardo Fernández-Arias
Rodolfo Manuelli
Juan S. Blyde
Editors

INTER-AMERICAN DEVELOPMENT BANK

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Contents

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Introduction

During the last two decades, a great deal of research has been conducted to explain what lies behind the large differences in income per capita that we observe across countries. Long-run economic growth is central for understanding these differences in per capita income. This book analyzes the sources of growth in Latin America and focuses on what is missing to sustain fast economic growth in the long run.

Latin American countries are falling behind. The growth record of Latin America in the recent past has been poor. For decades the average income per capita in Latin America has fallen relative to those of other countries, raising concerns about the capacity of the region to emulate more successful developing countries and lift its living standards closer to those of the developed world. What is failing?

Two overview chapters, six country studies and four background thematic studies have been assembled in this book to present a comprehensive answer to this question. The rest of this introduction gives a brief summary of the main findings.

The first two chapters offer an overview of Latin America's growth performance. Chapter 1 sheds light on the strengths and weaknesses of the growth process in Latin America by means of comparisons with other regions. Somewhat surprisingly, with this approach, Blyde and Fernández-Arias find that the 1990s were more successful than the "golden" 1960s. Two clear messages arise from this chapter: first, Latin America's relative performance is constantly poorer due to slower total factor productivity (TFP) growth; and second, this productivity growth in the region is impeded by the quality of its institutions. The authors acknowledge that other factors, such as bad economic policies, have also played a role. This is also a recurrent outcome across the country studies of the book. Economic policies, however, do not emerge in a vacuum, as they are adapted to the institutional environment in which the economy operates. This chapter seeks to convey that distortions to the institutional environment are likely to hamper TFP growth and that this has been the root of why Latin America has continuously been falling behind.

The main objective of the second overview chapter is to use economic theory to explain Latin America's main stylized facts. For this, Manuelli reviews the findings of the country studies included in this book as well as the evidence presented in region-wide analyses of Latin America (including the one in Chapter 1) and discusses some regularities among them. The author then uses very simple models of economic growth to rationalize these regularities. Manuelli's main motivation lies in the observation that standard growth models in which TFP is a technological variable seem to be poorly equipped to explain Latin America's growth process. TFP is influenced by policy, institutions and technology shocks in ways that Manuelli posits in simple models seeking to reconcile theory and observation. In the final part of his analysis, Manuelli summarizes each of the individual studies and provides a natural bridge to the subsequent country chapters.

The first country analysis is devoted to Argentina. Hopenhayn and Neumeyer focus their attention on understanding why the Argentine economy performed so poorly during the 15 years following 1975. The authors underscore the role of policies. Their major claim is that policy changes and the uncertainty associated with future policy reversals can account for most of the poor aggregate performance observed in Argentina during this time. In particular, policies that increased the cost of capital have a direct effect on output through the fall in the capital stock and an indirect effect that operates through a reallocation of labor induced by the fall in investment.

The subsequent chapter is a prime example of how policies and institutions are related to growth, particularly TFP growth. Analyzing the case of Brazil, Castelar Pinheiro, Gill, Servén and Thomas find that TFP growth was systematically associated with growth in the stock of machinery and equipment through capital-embodied technological progress. This suggests, for example, that the faltering of Brazil's stellar performance in the 1970s might have been in part the result of the government's response to external imbalances since, according to the authors, increasing barriers to imports on capital goods decreased embodied technological progress and thus productivity growth. The authors also highlight the impact of a poor institutional framework on overall efficiency. They argue that pervasive labor regulations, controls on foreign licensing and technology transfer, and a slow process of intellectual property protection might have been detrimental to productivity growth.

Policy reforms and changes in the institutional framework are also key features in Chumacero and Fuentes's narrative of Chilean economic performance. The authors show through a series of growth accounting exercises that the mild growth rates of the 1960s are mainly due to the accumulation of human and physical capital, while the booms of the mid-seventies and the one after 1985 are mainly due to TFP growth. They assert that the periods of high output are not only the periods of high TFP growth but also the periods in which there are major changes in domestic economic policy and institutional arrangements. In particular, periods of fast growth coincide with periods of liberalization of state control over the economy.

Chapter 6 is devoted to the economic growth experience of Paraguay. According to Fernández Valdovinos and Monge Naranjo, Paraguay's development failure is mostly driven by negative growth in TFP. Surprisingly, in the face of declining productivity, they observe that factor accumulation remained strong. Therefore, the authors devote a great deal of analysis to explaining this puzzle. They argue that the most significant decrease in TFP is contemporaneous with the construction of the large hydroelectric complex at Itaipú. The speculation is that this government-regulated project led to inefficiencies in the allocation of resources. This, of course, would also be consistent with the increase in factor accumulation as distorted incentives can compensate for declining productivity.

The results from the study on Peru also underline the links between bad policies and poor TFP performance. Carranza, Fernández-Baca and Morón present an interesting study in which one of the key findings is that high levels of the real exchange rate and high public debt, which can be viewed as indicators of policy-induced distortions, are associated with low

TFP. The authors also find that favorable terms of trade and low world real interest rates are associated with higher levels of TFP. Therefore, it appears that bad internal policies, even in the face of relatively benign external conditions, are responsible for the country's decline in measured TFP from the mid-1970s.

Finally, de Brun analyzes, in Chapter 8, the long-run economic performance of Uruguay. The main focus of the author is to investigate how policies affected the performance of the Uruguayan economy. The author identifies two major policy changes. The first came in 1973, when the Uruguayan government initiated a process of trade liberalization, and the second in the 1990s when Uruguay joined Mercosur—the Southern Cone free trade association—and, concurrently, instituted a series of market-oriented reforms. According to the author, these policy changes induced a process of human capital accumulation which resulted in an increase in the long-run level of income. According to de Brun, human capital accumulation played a critical role in the performance of the Uruguayan economy.

Part III of this book presents the four thematic papers that were used in the GDN project to guide the national country studies. These papers are focused on four key thematic areas: macro-growth, markets as institutions in the growth process, political economy and schooling investment.

In the paper on macro-growth, De Gregorio and Lee find that although the level and quality of human resources are important determinants of growth, they account for very little of the lower growth rate in Latin America. The main determinant is lack of TFP growth. Focused on the growth rate of GDP per capita, this paper also underscores the role of economic policy and institutional factors in accounting for the slower growth rate of output in Latin America. The work of De Gregorio and Lee contains a comprehensive set of statistics including growth decompositions by countries. It is thus an excellent reference for the sources of growth in the region.

In the second background paper, Hopenhayn and Neumeyer observe that most of Latin America's growth was driven by the accumulation of physical capital while productivity growth was nil (consistent with Blyde and Fernández-Arias and with De Gregorio and Lee). The authors go on to argue that distortions in the decisions to accumulate capital can explain this puzzle of high investment and low productivity. Policies that distort relative prices in either the output or input markets may artificially raise the return to capital and lead to over-accumulation in favored sectors. Good examples of these policies, they assert, are protectionism and subsidies to inputs provided by the public sector. Policies that directly distort the cost of capital, such as subsidized credit and tax advantages, can have similar effects.

In the next background paper, Rodríguez explores the political economy aspects of the determinants of economic growth in Latin America. He looks at the political weaknesses behind Latin America's poor economic performance. The paper finds political instability, inequality in the distribution of political and economic power, rent-seeking, and weak institutions to be the most important factors explaining how politics has influenced Latin America's growth rates. The author suggests that for policy reform to be successful, it must address the reasons for the region's high instability, its unequal distribution of political and economic powers, its prevalence of rent-seeking and, in general, its poor institutional structure.

The last background paper is devoted to analyzing the impact of aggregate conditions on schooling decisions in Latin America. Using a high-quality household-survey-based data set for 18 Latin American countries, Behrman, Duryea and Székely relate school attainment to macroeconomic stability, factor endowments, demographic developments, institutions, and culture and religion. They find that macroeconomic stability is the most significant determinant of schooling attainment and of the proportion of individuals that complete primary schooling. This conclusion is very important because it reveals that macroeconomic crises can have long-term negative effects through a vicious circle in which low growth and high macro volatility hamper schooling attainment, which in turn inhibits future growth.

The process by which countries grow is a complex phenomenon that can hardly be addressed using a single and unitary approach. As this summary shows, this book has been assembled integrating complementary approaches that include country analyses, regional analyses, and thematic studies. This multiplicity of dimensions provides a rich and comprehensive view of the growth process in Latin America and separates this book from other publications about the same topic. We hope that this material contributes to a better understanding of the growth phenomenon in Latin America and to the transformations needed for success.

Eduardo Fernández-Arias
Rodolfo Manuelli
Juan S. Blyde

Part I

What Is Wrong with Latin American Growth?

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CHAPTER 1

Why Latin America Is Falling Behind

Juan S. Blyde and Eduardo Fernández-Arias[1]

This chapter provides an overview of Latin American growth during the past four decades and then focuses upon the economic performance of the countries discussed in the second section of this volume—Argentina, Brazil, Chile, Paraguay, Peru, and Uruguay. The analysis sheds light on the strengths and weaknesses of long-term growth in Latin America by identifying similarities and differences with other regions and assesses economic performance on a comparative basis.

During the past four decades, many Latin American countries experienced episodes of economic crisis, political instability, and social unrest. At the same time, they also implemented economic stabilization policies, political reorganization, and structural reform. A cursory review of basic development indicators suggests a net positive result from these efforts. Generally speaking, income per capita, health, and education indicators improved. The underlying economic structure of the region became more integrated with global trade, and institutional quality and macroeconomic management improved. These achievements are shown in Table 1.1.

The achievements are impressive in many respects, yet how satisfactory are they? To tackle this issue, we focus on the per capita economic growth rate and its contributing factors. We compared the experience of a "typical" country in Latin America with that of benchmark countries—

[1] The authors are affiliated with the Inter-American Development Bank. They wish to thank Rodolfo Manuelli, Daniel Oks, and Andrés Solimano for their useful comments but take sole responsibility for the contents of this study. The conclusions and opinions expressed here do not necessarily reflect the policies or opinions of the IDB.

Table 1.1. Basic Indicators
(averages over decades)

	Real GDP per capita in 2000 dollars				Life expectancy at birth, total years				Years of education in ages 15 and up			
	1960s	1970s	1980s	1990s	1960s	1970s	1980s	1990s	1960s	1970s	1980s	1990s
Latin America	1,590	2,000	2,050	2,170	56	61	65	68	3.1	3.8	4.7	5.4
Rest of the world	2,380	3,350	4,100	4,810	58	61	65	67	3.3	4.3	5.3	6.3
Developed	13,420	18,860	23,160	27,790	71	73	75	77	7.1	7.8	8.7	9.4
East Asia	1,860	3,360	5,590	9,480	60	65	70	73	4.5	5.3	6.5	7.6

	Trade volume (% of GDP)				Annual inflation (%)				Index of institutional quality[b]			
	1960s	1970s	1980s	1990s	1960s	1970s	1980s	1990s	1960s	1970s	1980s	1990s
Latin America	37	44	48	57	11	30	240	164[a]	n.d.	n.d.	–1.3	–0.2
Rest of the world	55	67	72	78	4	11	14	10	n.d.	n.d.	1.0	1.6
Developed	47	55	61	64	4	10	10	7	n.d.	n.d.	3.0	3.4
East Asia	112	131	166	193	4	9	5	5	n.d.	n.d.	1.2	2.0

Sources: Penn World Tables, World Development Indicators (World Bank), International Country Risk Guide (ICRG).
[a] In the second half of the 1990s, the average inflation rate was 15 percent.
[b] First principal component of ICRG variables.
n.d.: no data available.

namely, "typical" countries for the rest of the world and for subsets of developed countries and East Asian countries.

Looking more closely, we found that between 1960 and 1999, Latin American countries experienced, on average, slower growth than did the rest of the world, particularly when compared to developed countries. This produced a widening of the income gap between Latin America and the developed world.

Why? The key to these differences is not factor accumulation but total factor productivity (TFP). In brief, slower TFP growth accounts for Latin America's slower growth relative to other regions. We provide econometric evidence suggesting that institutional quality—and to a lesser extent, lack of openness and macroeconomic instability—were important factors behind these differences in productivity growth.

The present chapter is organized as follows. First, we describe the economic performance of Latin America during the past four decades and then compare it with the experience of the benchmark countries. In the following section, growth accounting exercises determine the relative contributions of various factors to the differences in observed performance. Next, an econometric model is developed to explore the role of policy and institutional variables that drive these contributions. For perspective on the country studies presented in this volume, the following section examines performance of the selected countries. We compare country growth performance with the rest of Latin America and with other benchmarks. Finally, we sum up the main findings and offer some concluding observations.

Latin America's Economic Performance in Perspective

To compare Latin America with other benchmark countries, we created a sample of 73 countries—20 Latin American countries[2] and 53 from the

[2] Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela.

rest of the world.[3] Of the non–Latin American countries, 20 belong to the developed world[4] and 5 are from East Asia.[5] In constructing benchmarks, we use simple unweighted averages across countries in the control group to account for the growth experience of the "typical" country from that group. Our key summary measure for economic performance is the growth rate in real GDP per capita adjusted for purchasing power parity. The list of measures that were used for this analysis, including the source of data for each, is shown in Appendix 1.A.

Figure 1.1 presents the annual growth rate of GDP per capita for the typical Latin American country over the past four decades. Overall, Latin American countries made progress between 1960 and 1999 despite shrinkage during the 1980s, often referred to as "the lost decade." The average growth rate of GDP per capita during the 1990s, however, was slower than that of the 1960s or 1970s. It comes as no surprise that the latter are often perceived as "golden decades," while the 1990s are generally considered a disappointment.

Longitudinal comparisons of absolute growth rates, however, can be somewhat misleading. When comparing Latin America with other regions—rather than with itself across decades—the story is quite different (Figure 1.2). Comparators consistently outperformed Latin America across the four decades—which is to say, Latin America lost ground relative to the rest of the world. Contrary to the message that might be read into Figure 1.1, the region's relative performance was worse during the 1960s and 1970s, and relatively better during the 1990s. In other words, the "golden decades" were golden for the rest of the world, too—not a reflection of unique Latin

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[3] This is the largest set of countries for which complete data were available. The countries are: Australia, Austria, Belgium, Benin, Botswana, Cameroon, Canada, Cote d'Ivoire, Cyprus, Denmark, Egypt, Fiji, Finland, France, Germany, Ghana, Greece, Hong Kong, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kenya, Korea, Madagascar, Malawi, Malaysia, Morocco, the Netherlands, New Zealand, Norway, Pakistan, Papua New Guinea, Philippines, Portugal, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Thailand, Togo, Tunisia, United Kingdom, United States, and Zimbabwe.

[4] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, and United States.

[5] Hong Kong, Korea, Malaysia, Singapore, and Thailand.

Figure 1.1. GDP Per Capita Annual Growth in Latin America

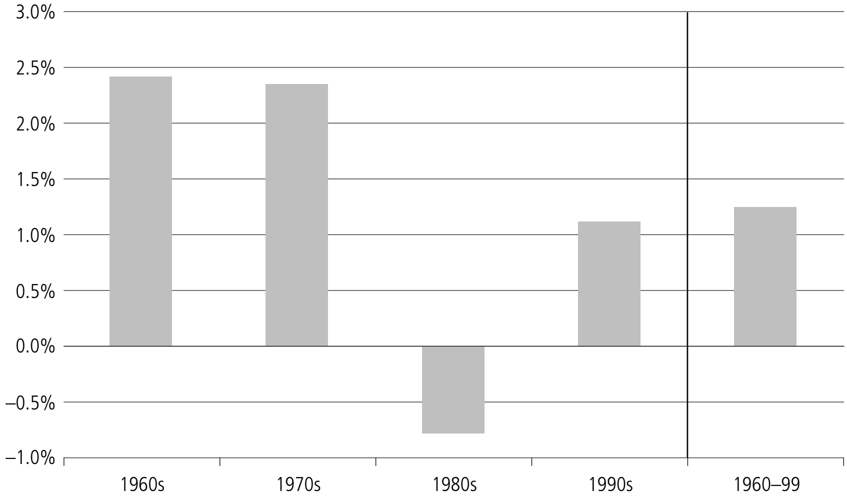

Figure 1.2. Difference in GDP Per Capita Annual Growth between Latin America and Comparators

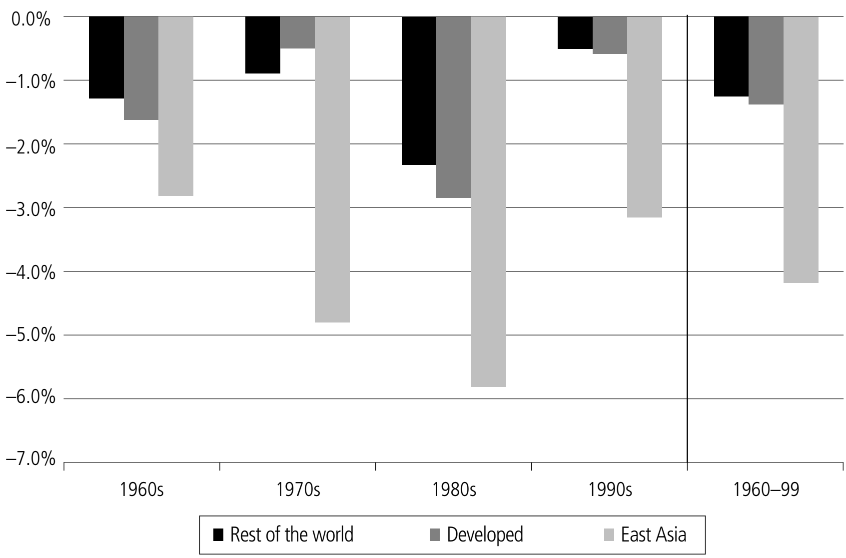

Table 1.2. Ratio of Latin American Income Per Capita with Respect to Comparators
(in percent)

	1960s	1990s
Rest of the world	87	59
Developed	31	20
East Asia	128	31

Note: Based on real GDP per capita (PPP).

American virtue during these times.[6] This finding confirms Fernández-Arias and Montiel (2001), which used this differential approach to assess the growth effect of reforms undertaken in the early 1990s.

Although Latin America performed relatively better during the 1990s, its average growth rate was still below that of the rest of the world. Unfortunately, the 1990s were no different from the other decades. The region experienced a relative regress. Accordingly, the income per capita relative to comparators worsened (Table 1.2). In the following subsection, we seek to understand the origins of this poor performance.

Beyond averages, the swings in per capita growth rates across decades indicate the instability of Latin American growth performance. Low persistence of country growth performance is a well-known fact established by Easterly et al. (1993) as a general feature in the world over a similar period (and historically). In our sample, we find Latin American countries to be particularly unstable. Their correlation coefficient of growth per worker between the first two decades (1960s, 1970s) and the past two (1980s, 1990s) is 0.26 lower than a respectable correlation of 0.45 for our full sample of 73 countries.[7]

[6] It is worth noting that the golden decades still look better than the 1990s if weighted averages are used to make the comparisons. However, as pointed out by De Gregorio and Lee (Appendix A), this misperception has occurred among some analysts because the weighted results strongly reflect the vigorous performance of Brazil and Mexico during this time. Unweighted averages provide a more telling comparison by better reflecting the growth experience of more "typical" countries.

[7] These relatively high correlation coefficients differ significantly from the lack of correlation found by Easterly and Levine (2001) for a larger sample of countries over a similar period. Analysis of our sample reveals, first, that their lack-of-correlation result changes significantly when periods are updated, and second, that results vary with the inclusion of some countries that we chose to discard from our sample because of questionable data.

Accounting for Performance

In this section, we perform growth and level accounting exercises based on a Cobb-Douglas production function to identify the proximate causes of growth performance. First, let Y represent domestic output; K physical capital; L labor force; h the average quality of the labor force, scaled in such a way that hL measures human capital in units of unskilled labor; and A total factor productivity, that is, the combined productivity of physical and human capital:[8]

$$Y = K^{\alpha}\left(hL\right)^{1-\alpha} A. \tag{1.1}$$

The production function can be written in terms of the number of workers, as follows:

$$\frac{Y}{L} = \left(\frac{K}{L}\right)^{\alpha} h^{1-\alpha} A. \tag{1.2}$$

In order to account for the growth rate in per capita terms, we can express (1.2) in terms of the entire population rather than the labor force. Let P be total population. We can use the relationship

$$\frac{Y}{P} = \frac{L}{P} \times \frac{Y}{L} \tag{1.3}$$

to express (1.2) in income per capita terms:

$$\frac{Y}{P} = \frac{L}{P}\left(\frac{K}{L}\right)^{\alpha} h^{1-\alpha} A. \tag{1.4}$$

In terms of growth rates, this is expressed as follows:

[8] In this specification, TFP excludes the effect of changes to the skill level of the labor force, which is captured by h and accounted as factor accumulation of human capital.

$$\left(\frac{\hat{Y}}{P}\right)=\left(\frac{\hat{L}}{P}\right)+\alpha\left(\frac{\hat{K}}{L}\right)+(1-\alpha)\hat{h}+\hat{A}. \tag{1.5}$$

The output and population data are taken from Penn World Table 5.6. The capital stock series are taken from Easterly and Levine (2001), which is consistent with Penn World Table 5.6. The labor input is measured by the labor force. These data are taken from the World Development Indicators of the World Bank.

Alternatively, factor inputs could be measured only to the extent to which they are actually utilized in production—that is, labor input could be measured by employment, excluding the unemployed; and capital input could be measured according to its actual utilization rate. Appendix 1.B describes how this alternative measurement would constitute a narrower definition of productivity and shows that using employment as labor input would not qualitatively change our findings.

We follow Hall and Jones (1999) in taking h to be relative efficiency of a unit of labor with E years of schooling. Specifically, the function takes the form

$$h=e^{\phi(E)}, \tag{1.6}$$

in which the derivative $\phi'(E)$ is the return to schooling estimated in a Mincerian wage regression. We take Hall and Jones's approach and assume the following rates of return for all the countries: 13.4 percent for the first four years, 10.1 percent for the next four years, and 6.8 percent for education beyond the eighth year. Average quality of the labor force (h) results from applying (1.6) to the average years of schooling of the labor force. Finally, we consider a capital income share α of 1/3. Sensitivity analysis, however, showed no qualitative differences in the results when we use capital shares of 0.4 or 0.5.

The contributions of the various components in (1.5) to account for the overall effects on income per capita (Y/P) help identify the proximate drivers of growth. The first component, L/P, measures the labor participation rate, that is, the labor force as a proportion of total population.[9] The second component refers to capital intensity (K/L) and measures the effect of physical capital accumulation. The third component refers to labor skills h and measures the effect of human capital accumulation. The combined effect of these three components can be interpreted as the effect of factor accumulation. These are, respectively, labor force size, physical capital intensity, and the skill level of the labor force. The final component (A) is obtained as a residual once the effect of the rest of the observable variables on income per capita (that is, the effect of factor accumulation) is accounted for. This last component thus measures the effect of TFP.

As it turns out, TFP is a key to explaining several observed trends in the evolution of income per capita, so we need to be precise in how our estimations are interpreted. Evidently our measure of TFP partially reflects available technology. However, this is not central to our interpretation of TFP because our main findings are based on gaps that appear in cross-country comparisons that, in principle, could benefit equally from technological progress, thus rendering no effects on the gaps. Apart from technology, our measure of TFP also incorporates the degree to which available factors of production—both physical and human capital—are utilized. This is so because we chose to account for all available production factors. These include nonutilized physical capital and unemployed labor. This means that waste in these resources because of nonutilization gets reflected into a lower TFP. This more encompassing measure of TFP is quite important to explaining cyclical variations driven by factor utilization rates, yet once again it is relatively unimportant in explaining results over the long run.[10] For analysis of long-run results, our preferred interpretation of TFP to explain gaps between countries (especially when they change) is that they capture distortions in the workings of the economy that drive aggregate efficiency below the technological frontier. This is the case even when each firm is technologically efficient at the micro level (Parente and Prescott, 2002).

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[9] A more detailed analysis can decompose this component into a demographic factor dealing with the fraction of the population of working age and a behavioral factor concerning their participation rate in the labor force—in other words, the fraction of the able who are willing to work.

[10] For further explanation, see Appendix 1.B: Measures of TFP.

As expected, TFP explains a large portion of the annual variability of GDP per capita in every region of the world (Easterly and Levine, 2001). For the typical Latin American country, the contribution of TFP even exceeds 100 percent, implying that TFP was more volatile than output. As reported by De Gregorio and Lee in Appendix A, this also holds for many individual Latin American countries.

Yet despite TFP being the dominant driver underlying *variability*, it is relatively insignificant as an explanation for *long-term* annual growth rates in Latin America. As shown in Figure 1.3, factor accumulation (resulting from labor participation rates, workers' skills, and physical capital intensity) was the primary driver in explaining regional progress between 1960 and the end of the millennium.

If we consider the contributions of productivity by decade, the results are mixed. The effect of TFP was a dominant positive factor in the 1960s, a dominant negative factor in the 1980s, and negligible in the 1970s and 1990s (Figure 1.4). It would be difficult to explain negative contribu-

Figure 1.3. Growth Accounting
(average annual growth rates, 1960–99)

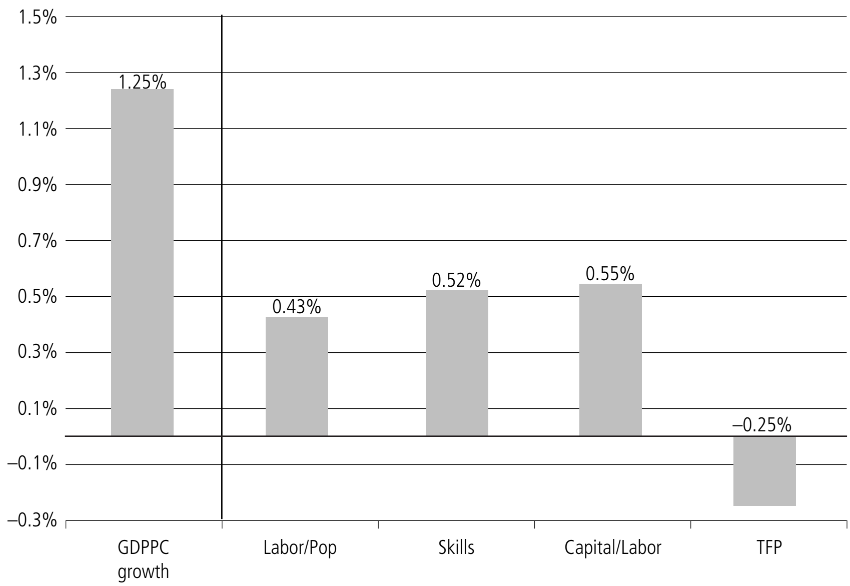
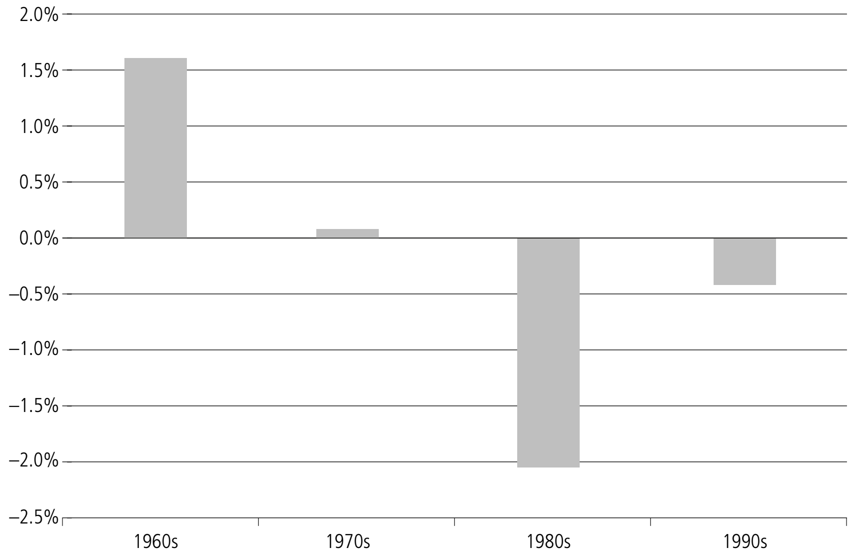


Figure 1.4. Average Annual TFP Growth Rate in Latin America by Decades



tion for an entire decade, such as the 1980s, as a technology reversal. In Appendix 1.B, we argue that our measure of productivity is associated with a broad definition of efficiency because it also captures changes in input utilization. However, Figure 1.B.1 shows that the reductions in the utilization of labor account for only a very small part of the drop in productivity during the 1980s, leaving a very large portion of the decline unexplained. As argued earlier, a more plausible explanation is that a rising level of distortions worked to hinder the operational efficiency of the economy. The decline in aggregate efficiency was translated directly into the productivity measure because it is calculated as a residual from the aggregate production function.

Pursuing our comparative approach, we can make further use of these growth accounting exercises to examine the factors underlying the slower growth of Latin America relative to the benchmarks over the four decades (Table 1.3). As shown, the lack of TFP growth is not only very important in accounting for the region's slower growth relative to compara-

Table 1.3. Differences in Contributions to Average Annual Growth between Latin America and Comparators, 1960–99
(in percent)

	GDP per capita growth	Labor/Pop	Skills	Capital/Lab	TFP
Rest of the world	–1.25	0.19	–0.01	–0.35	–1.07
Developed	–1.38	0.02	0.14	–0.38	–1.16
East Asia	–4.19	–0.33	–0.13	–1.62	–2.11

tors, it is the primary factor in accounting for the growth gap over this period.[11]

It is worth noting that the results across regions in Table 1.3 are also consistent across decades (Table 1.4). The only exceptions are the developed countries in the 1960s and the East Asian countries in the 1990s, in which slower capital accumulation was the key factor accounting for the growth gap.

The main finding—that TFP is the dominant factor accounting for Latin America's gap in growth with comparators—also applies quite uniformly across countries within the region. Figure 1.5 shows the differences in growth contributions between 1969 and 1999 for each Latin American country as well as developed countries. As shown, many growth differences in labor participation and skills are, in fact, positive. On the other hand, negative differences are very common in the growth rate of capital accumulation. Yet the greatest negative differences are seen in TFP growth. This is true for every country in the sample (except for Bolivia, where the greatest difference is in capital accumulation). If other benchmarks are used, the results remain similar.

Up to this point, we have shown that Latin America's slower growth relative to the benchmarks is primarily the result of the region's slower

[11] Sensitivity analysis with a capital share of 0.4 shows that slow TFP growth in Latin America remained the dominant factor accounting for the growth gap with all regions except East Asia. In this case, lack of capital accumulation emerges as the most important factor accounting for the growth gap during 1960–99.

Table 1.4. Differences in Contributions to Average Annual Growth between Latin America and Comparators by Decades, 1960–99
(in percent)

	GDP per capita growth	Labor/Pop	Skills	Capital/Lab	TFP
		1960s			
Rest of the world	−1.29	−0.10	−0.07	−0.54	−0.58
Developed	−1.63	−0.34	0.01	−0.91	−0.38
East Asia	−2.82	−0.49	−0.20	−0.96	−1.17
		1970s			
Rest of the world	−0.89	0.04	0.06	−0.22	−0.78
Developed	−0.50	−0.20	0.22	0.01	−0.52
East Asia	−4.81	−1.02	−0.15	−1.36	−2.27
		1980s			
Rest of the world	−2.21	0.40	0.10	−0.56	−2.15
Developed	−2.85	0.12	0.23	−0.45	−2.74
East Asia	−5.71	−0.07	0.02	−1.95	−3.72
		1990s			
Rest of the world	−0.50	0.38	−0.03	−0.11	−0.74
Developed	−0.58	0.46	0.11	−0.23	−0.91
East Asia	−3.15	0.26	−0.09	−2.14	−1.18

TFP growth. Yet this tells us nothing about the size of the income gap. How far is Latin America behind other regions in terms of each of the resource factors that contribute to income? To answer that question, we perform level accounting exercises. To simplify the exposition, we leave aside differences in labor participation and perform level accounting exercises with respect to income per worker. The exercises are based on the following equation:

$$\left(\frac{y}{y^*}\right)=\left(\frac{k}{k^*}\right)^{\alpha}\left(\frac{h}{h^*}\right)^{1-\alpha}\frac{A}{A^*}, \qquad (1.7)$$

Figure 1.5. Differences in Average Annual Growth Contributions between Latin America and Developed Countries, 1960–99

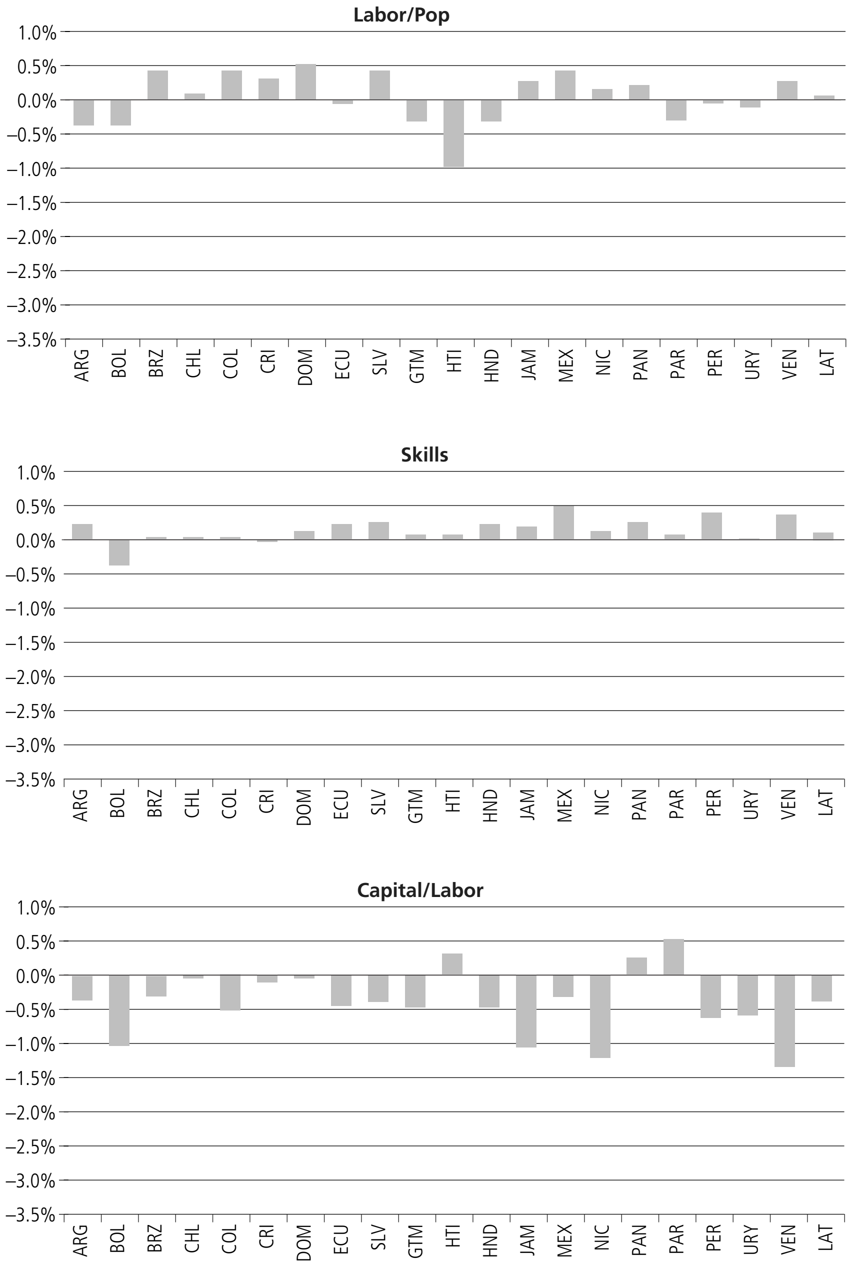
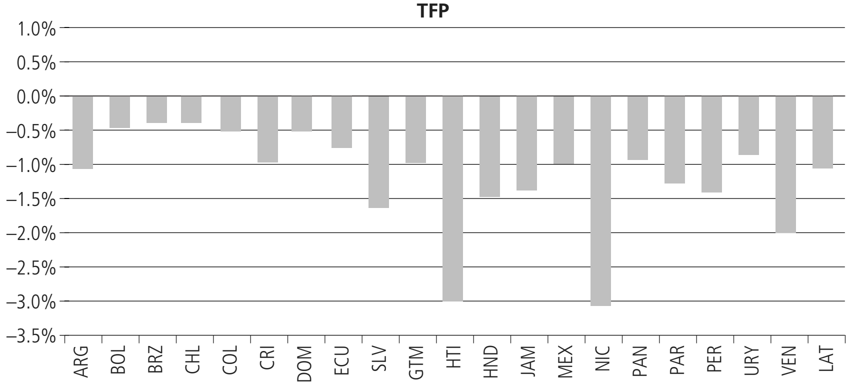


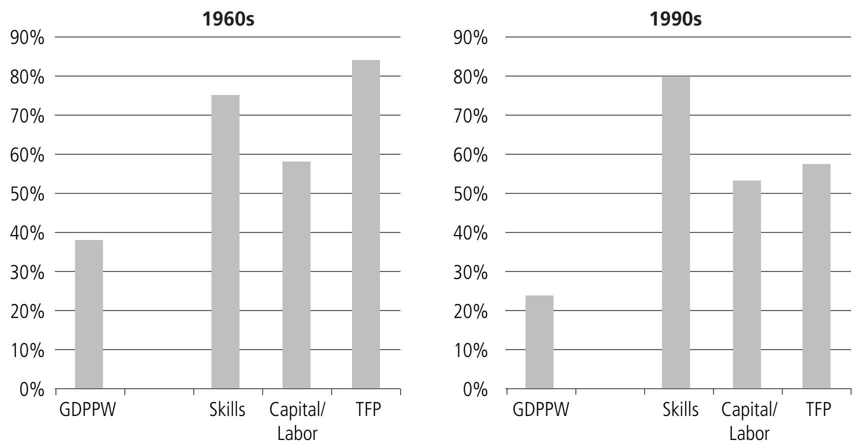
Figure 1.5. Differences in Average Annual Growth Contributions between Latin America and Developed Countries
(continued)



in which y is real GDP per worker and k is capital per worker. Variables with an asterisk refer to the typical developed country from the sample, and variables without an asterisk refer to the typical Latin American country.

Results of this analysis are presented in Figure 1.6. In the left-hand graph, the first column, GDPPW, shows income per worker in Latin America during the 1960s relative to that of his counterpart in the developed countries. We see that worker productivity in Latin America was 37 percent of

Figure 1.6. Level Accounting: Latin America Relative to Developed Countries



that in developed countries. The next three columns represent each factor's relative contribution. It is the shortfalls in each of these three contributions that combine to produce the result. Following (1.7), the product of these three columns is equal to the value of the relative income per worker shown in the first column ($0.37 = 0.76 \times 0.58 \times 0.84$). The exercise is repeated for the 1990s in the right-hand graph. In both cases, lower capital-labor ratios are the main cause of lower incomes.

The income per capita in Latin America relative to that in developed nations dropped from 37 percent at the beginning of the 1960s to 24 percent in the late 1990s. During 1960–99, the TFP gap widened in Latin America—dropping from about 84 percent of the developed countries' TFP in the 1960s (a relatively modest shortfall) to 58 percent in the 1990s. This collapse in relative TFP—by nearly 30 percentage points—was key to the similar decline in relative income. In fact, the other two growth contributions largely offset each other. Labor skills progressed marginally from 76 percent to 80 percent; however, physical capital intensity regressed—from 58 percent to 53 percent.

What should be made of these shortfalls and trends? One clear insight is that labor force skills were not the key to Latin America's (relatively) low and deteriorating income. To the contrary, if the skills of the labor force were the only difference from developed countries, income per worker would be as high as 80 percent (that is, similar to the level of Spain), and it would be improving over time. Notwithstanding the benefits of policies aimed at improving labor force skills to increase average income,[12] the key to Latin America's dismal and worsening relative income—to about a quarter of developed countries'—is to be found in physical capital and TFP.

A second insight is that physical capital intensity in Latin America—even though it was low and declined relative to developed countries—did not follow an anomalous path. Instead, it evolved precisely as would be expected in profit-driven capitalist economies. Investment and, even more

[12] Policies to improve the skills of the labor force, especially when focused on the disadvantaged, may also be considered in regard to poverty alleviation and social inequities, though that issue is outside the scope of this study.

strongly, the stock of physical capital is determined by the existence of profitable opportunities in the economy, as measured by marginal returns to investment, r and r^*, derived from (1.1):

$$\alpha \frac{y}{k} = r \tag{1.8a}$$

$$\alpha \frac{y^*}{k^*} = r^*. \tag{1.8b}$$

Equations (1.8a) and (1.8b) yield

$$\frac{y}{y^*} = \delta \frac{k}{k^*} , \tag{1.9}$$

in which $\delta = \frac{r}{r^*}$.

Figure 1.6 implies that in the 1960s, δ was around 1.9; and in the 1990s it was around 1.7. The gap between rates of return to physical investment (δ) is used as a measure of financial integration in Latin America. That is, $\delta = 1$ would mean perfect integration. The higher δ is, the less integrated, so that excess returns would remain unexploited.[13] Under this interpretation, improving financial integration to the point of perfection could improve relative income only to 31 percent, still below its 1960s level. This is also roughly equivalent to the improvement in income that would occur through total elimination of the skills gap. Alternatively, δ may reflect other costs associated with investment—for example, taxation or risk of expropriation or a risk premium because of uncertainty. In that case, the policy alternatives that would generate higher capital intensity lie elsewhere.

Once again, analysis reveals that the TFP gap was the key to Latin America's low and declining relative income. It should be noted, first, that if Latin America were to increase its TFP to the level of developed coun-

[13] In this formulation, r and r^* refer to gross returns, inclusive of depreciation. Another interpretation is that δ reflects different depreciation patterns in investment in both types of economies.

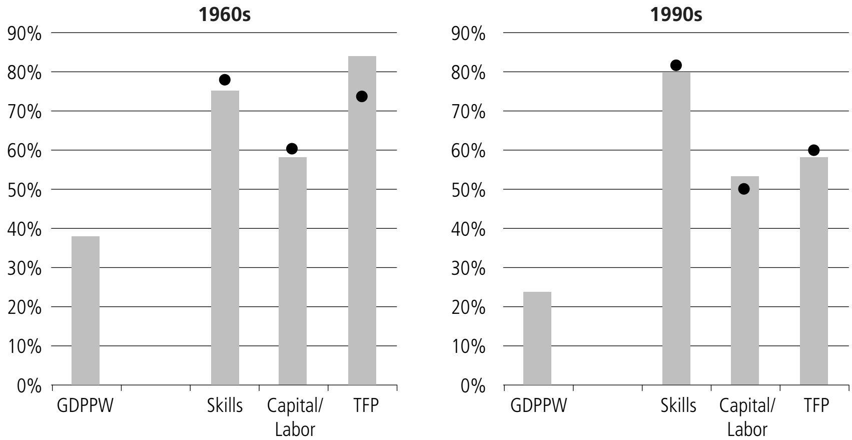
tries—that is, with the same physical and human capital resources that are now in place—relative income would significantly rise by 18 percentage points to total 42 percent. Second and equally important: as impressive as these measures of the TFP gap's significance may be, they severely underestimate the impact of the TFP shortfall. Indeed, the TFP handicap has equally important indirect effects on lower incomes. Why? Because low productivity underlies low stocks of physical capital and, to some extent, human capital because it reduces returns to investment. Leaving aside any effects on the incentives for human capital accumulation and on the rate-of-return gap δ, a conservative estimate of the indirect effects of closing the TFP gap is that relative income per worker would increase an additional 13 percentage points through the increase of the equilibrium physical capital stock in (1.9).

By conservative estimation, closing the TFP gap would improve the relative income of the typical Latin American country by 32 percentage points, up to 56 percent—that is to say, a level similar to that of Portugal or Greece. It is therefore essential to analyze the factors that underlie TFP performance as well as the policies that could be employed to increase it. This poses a research agenda that we will return to in the concluding section.

Another approach to learning from Figure 1.6 about the nature of the shortfalls is to look at their relative imbalances with respect to a benchmark of normal economic development, which may reveal important features of the growth performance in Latin America. In what follows we utilize a prediction model for the variables in Figure 1.6, that is, the relative gaps with respect to developed countries, controlling for the level of development of countries as measured by income per capita on the basis of world cross-country experience in each period. We then apply this model to Latin American income levels to construct a benchmark of normal development and contrast it with the actual performance shown in Figure 1.6 (see Figure 1.7).

The fact that Latin America exhibits gaps in all the contributing factors (Figure 1.6) is not so surprising in light of the region's lower level of development. An interesting question, however, is whether the size of these gaps is consistent with the levels of income observed *within* Latin America. In Figure 1.7, bars are once again used to indicate the relative levels of the

Figure 1.7. Level Accounting: Latin America Relative to Developed Countries



Note: Dots indicate relative levels after adjusting for income per worker.

contributing factors, and dots are used to indicate these same relative levels adjusted by the level of development.[14] During the 1960s, the relative level of TFP in Latin America was greater than would have been expected from its development stage. With respect to skills and physical capital, the opposite was true. These imbalances disappeared by the 1990s. By then, the relative levels of these contributing factors were more in tune with the levels of development of the region. They were marginally lower in terms of skills; they were marginally higher in terms of physical capital; and they were slightly lower in terms of TFP. This finding suggests that the substantial decline in levels of productivity by the 1990s was partly the result of an adjustment from levels in the 1960s that were relatively high but atypical.

Latin America is no longer characterized by development imbalances. At the present stage, accumulated physical and human capital appear to match productivity. During the 1960s, an argument could justifiably

[14] For this, we regressed the log of each contributing factor on the log of income per worker using the entire sample of countries excluding the Latin American countries in each decade. We then calculated the level of the contributing factor that Latin America should have had in each decade according to its level of development using the regression estimates and the observed income per worker for Latin America.

be made for unleashing development through faster accumulation to exploit high productivity. However, today's situation calls for a focus on productivity.

For perspective on the size of the gaps across Latin America, Figure 1.8 shows level accounting exercises for individual countries during the 1990s. We decompose the income gaps and their components with respect to developed countries by taking logarithms in equation (1.7). (For presentational purposes, we multiply all the values by –1.0.)

Figure 1.8 provides useful information on the relative gaps for each country and identifies deficiencies that may require policy attention. For example, simple comparison between Mexico and Argentina reveals roughly similar income gaps relative to the developed countries in the 1990s. However, the relative gaps in skills and capital per worker were higher in Mexico than in Argentina, and the relative gap in TFP was smaller.

Figures 1.9 through 1.11 show the differences between the observed and expected levels of each contributing factor. (The expected level of development of each country is its deviation from the norm.) Let us return to the previous example of Mexico and Argentina. The figures show that Mexico had lower-than-expected levels of skills and capital per worker, while Argentina had lower-than-expected levels of TFP. From the perspective of policy

Figure 1.8. Gaps in Levels between Latin America and Developed Countries in the 1990s

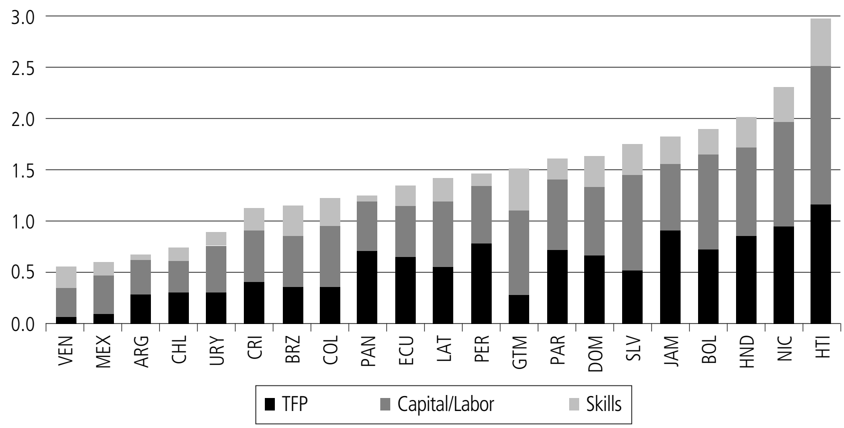
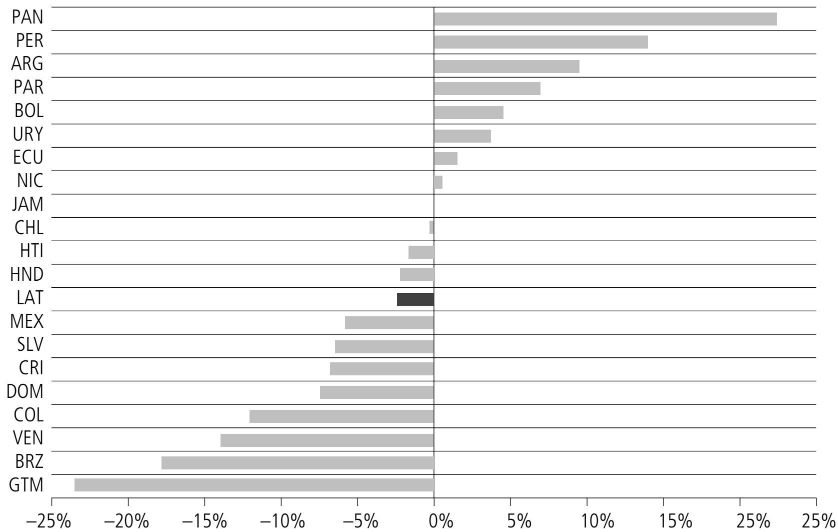
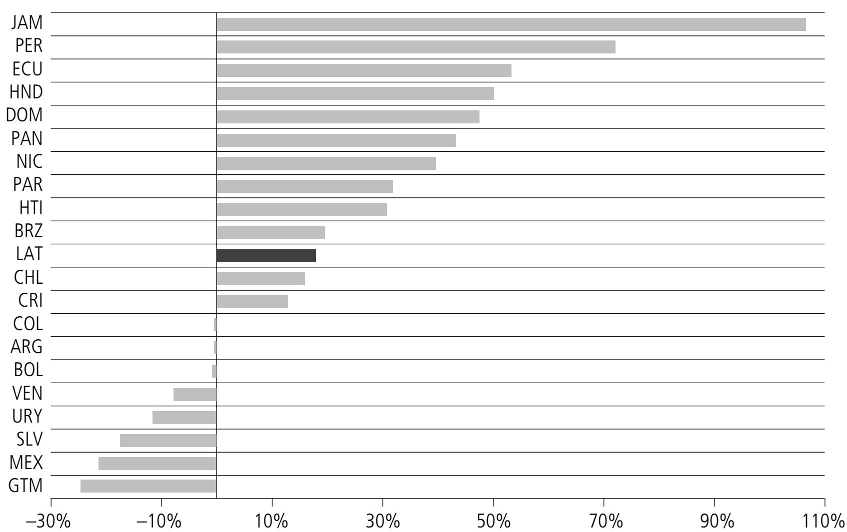


Figure 1.9. Differences in Skill Levels after Adjusting for Development in the 1990s



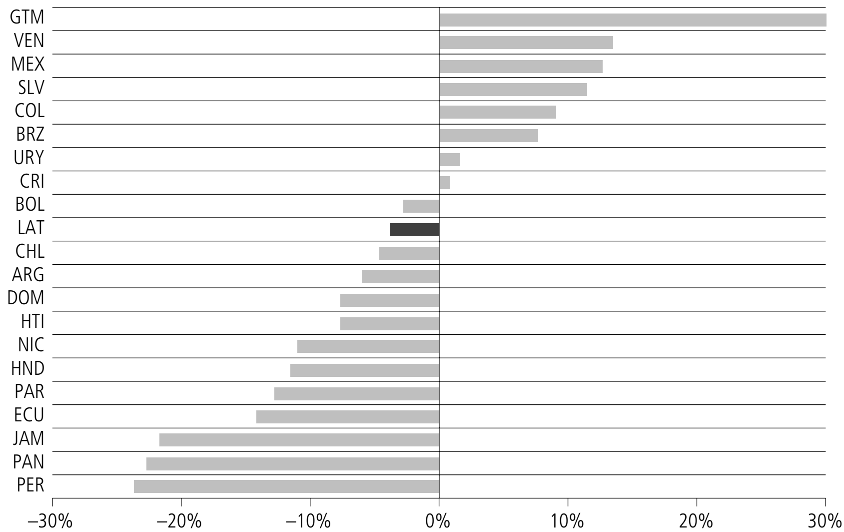
Note: Positive values indicate that the current level is higher than predicted by level of income.

Figure 1.10. Differences in Capital/Labor Levels after Adjusting for Development in the 1990s



Note: Positive values indicate that the current level is higher than predicted by level of income.

Figure 1.11. Differences in TFP Levels after Adjusting for Development in the 1990s



Note: Positive values indicate that the current level is higher than predicted by level of income.

action, this kind of analysis suggests the size of the shortfall that needs to be addressed, and it provides a conceptual framework in which to set priorities. We now turn to the next question: *which* policies would be most effective in addressing these shortfalls?

Explaining Productivity Growth

Our analysis shows, first, that lower productivity is the main factor explaining lower income in Latin America and, second, that slow productivity *growth* is the main factor explaining the relatively poor performance of the typical Latin American country versus relevant comparators. The question, then, is: what drives productivity?

To address that central problem, we then analyzed TFP growth through Barro-style regressions. We ran similar regressions on factor growth, thus sharpening our analysis and reconciling our results with more traditional growth regressions (which do not distinguish between factor growth and TFP growth components). Indeed, our estimates of growth effects are obtained by combining the effects on factor growth with those on TFP growth.

We distinguished among a wide range of explanatory variables—public policy variables, the quality of institutions within which policies and economic decisions are carried out, and external factors such as terms-of-trade shocks. The policies are proxied by the following variables:

- Education—log of average years of secondary schooling in the male population over age 25;
- Life expectancy—log of average years of life expectancy at birth;
- Openness—structure-adjusted trade volume as a percentage of GDP;[15]
- Imports of machinery and equipment—log of machinery and equipment as a percentage of GDP;
- Credit to the private sector—log of credit to the private sector as a percentage of GDP;
- Government consumption—log of government expenditure as a percentage of GDP;[16]
- Inflation—log of inflation rate; and
- Black-market premium—log of 1 plus black-market premium.

Institutions are proxied by the first principal component of the variables in the International Country Risk Guide (ICRG). This proxy combines risk of repudiation of contracts by government, risk of expropriation, corruption, rule of law and bureaucratic quality.

The terms-of-trade shocks are measured by the growth rate of the terms of trade. The panel data consist of a sample of 73 countries and six

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[15] The idea of adjusted trade volume is taken from Pritchett (1996). It is measured as the residual of the following equation: $(IMPORTS + EXPORTS) / (GDP)_i = a + b^*\log(POB)_i + c^*\log(AREA)_i + d^*\log(GDPPC)_i + e^*\log(GDPPC)_i^*\log(GDPPC)_i + f^*\ OIL\_dummy_i + g^*LANDLOCK\_dummy_i + E_i$. The measure indicates the volume by which a country's trade intensity exceeds (or falls short of) that expected for a country with similar characteristics.

[16] Expenditures for defense are not included.

five-year-average subperiods from 1970–74 to 1995–99. We control for conditional convergence by including the initial per capita GDP and by cyclical reversion to the long-run trend within each five-year period (Loayza, Fajnzylber, and Calderón, 2004).[17]

Unfortunately, data to construct most of the variables for the index of institutions are available only from 1982 or 1985 onward. To fully analyze the four decades being studied, we used a predictive model, based on the explanatory variables of the growth model, to construct an index of institutions for the early subperiods for which data were unavailable. Here, we follow Fernández-Arias and Montiel (2001) in constructing missing values of the structural reform index to explain GDP growth. Consider the following equation:

$$I_{it} = a + bM_{it} + e_{it}, \tag{1.10}$$

in which I_{it} is the index of institutional quality, and M_{it} is a set of the explanatory variables included in the growth model (policy-related variables and the terms-of-trade shocks). Equation (1.10) is estimated using data for the subperiods 1985–89, 1990–94, and 1995–99. With the estimated parameters of the model and data values of M_{it} for the subperiods 1970–74, 1975–79, and 1980–84, we then estimate the missing values of I_{it}.[18]

Tables 1.5 and 1.6 provide a complete definition of all the variables, including their descriptive statistics and correlations for the sample of 73 countries during the entire 1970–99 period. We control for potential endogeneity in all the regressions using instrumental variable (IV) estimation based on lagged values.

[17] That study considers the cyclical reversion to the long-run trend in GDP per capita. In contrast, since our estimate of TFP reflects changes in the rates of factor utilization (as explained in Appendix 1.B), which are the key to economic fluctuations, we control for the economic cycle in our three regressions by the cyclical reversion to the long-run trend in TFP.

[18] It should be noted that this procedure does not add any new information to the growth regressions, but it allows us to use the entire sample available. The estimation of equation (1.10) produces an *R*-squared value of .68.

Table 1.5. Descriptive Statistics, 1970–99

Variable	Description	Obs.	Mean	Std. dev.	Min.	Max.
GRGDPPC	Growth rate of GDP per capita	438	0.018	0.028	–0.083	0.124
GRA	Growth rate of TFP	438	0.001	0.022	–0.074	0.067
GFAC	Growth rate of factors	438	0.017	0.014	–0.017	0.078
LGDPPC	Initial GDP per capita (in logs)	438	8.177	0.962	6.152	9.854
CYCLEA	Cyclical reversion in productivity: initial productivity gap relative to trend (in logs)	438	0.009	0.068	–0.217	0.242
LSHYRM	Education: average years of sec and higher schooling in male pop with 25+ (in logs)	420	0.383	0.885	–3.101	1.895
LLIFEE	Life expectancy at birth, years (in logs of [years/100])	438	–0.440	0.173	–1.059	–0.220
OPEN	Openness: structure–adjusted	426	0.029	0.388	–0.537	2.713
LINFLA	Inflation (in log of [1 + infla/100])	429	0.185	0.406	0.003	3.543
LBMP	Black market premium (in log of [1+bmp])	438	0.152	0.374	–0.105	4.767
LCREDIT	Credit to private sector/GDP (in logs)	426	–1.090	0.785	–3.953	0.712
LGOV	Government consumption/GDP (in logs)	425	–1.965	0.381	–3.133	–0.950
LMACHIN	Imports of machinery and equipment/GDP (in logs)	438	–3.092	0.657	–5.486	–0.468
GTOT	Growth rate of terms of trade	410	0.000	0.041	–0.328	0.301
ICRG	First principal components of ICRG variables	417	0.000	2.064	–4.133	3.075

To explore the strength of the associations, we first perform bilateral regressions for TFP growth as well as for GDP per capita growth and factor growth (see Table 1.7). For this exercise, we estimate the impact of each explanatory variable. In all the cases, we control for conditional convergence and cyclical reversion. The results show that our proxies for education, life expectancy, openness, imports of machinery and equipment, credit to the private sector, institutions, and terms-of-trade growth rate all have positive individual effects on TFP growth as well as on GDP per capita growth and factor growth (though not all effects are statistically significant). Inflation and black-market premium, which are proxies for policy mismanagement, have negative associations with the three variables. The

Table 1.6. Correlations, 1970–99

	GRGDPPC	GRA	GFAC	LGDPPC	CYCLEA	LSHYRM	LLIFEE	OPEN	LINFLA	LBMP	LCREDIT	LGOV	ICRG	GTOT	LMACHIN
GRGDPPC	1.000														
GRA	0.870	1.000													
GFAC	0.608	0.137	1.000												
LGDPPC	0.187	0.143	0.146	1.000											
CYCLEA	–0.054	–0.302	0.377	0.028	1.000										
LSHYRM	0.161	0.160	0.065	0.804	–0.171	1.000									
LLIFEE	0.246	0.148	0.255	0.856	–0.068	0.775	1.000								
OPEN	0.213	0.159	0.173	0.006	–0.057	0.006	0.033	1.000							
LINFLA	–0.262	–0.220	–0.171	–0.117	–0.110	–0.069	–0.081	–0.183	1.000						
LBMP	–0.347	–0.269	–0.263	–0.272	–0.035	–0.210	–0.265	–0.126	0.420	1.000					
LCREDIT	0.224	0.143	0.220	0.680	–0.002	0.582	0.643	0.228	–0.214	–0.411	1.000				
LGOV	–0.037	0.053	–0.160	0.387	0.022	0.255	0.229	0.014	–0.089	–0.052	0.289	1.000			
ICRG	0.268	0.284	0.082	0.829	–0.069	0.745	0.700	0.169	–0.238	–0.376	0.662	0.490	1.000		
GTOT	0.086	0.093	0.024	0.088	–0.063	0.078	0.132	0.024	–0.089	–0.095	0.104	0.004	0.133	1.000	
LMACHIN	0.187	0.142	0.147	0.167	–0.058	0.147	0.182	0.703	–0.164	–0.118	0.220	0.248	0.301	0.093	1.000

Note: See Table 1.5 for definitions of variables.

government consumption variable, which often appears with a negative sign in growth regressions, is normally taken as an indicator of the burden imposed by public sector interference with markets. Our regressions suggest that this negative effect on the growth rate of output is the result of crowding-out effects on private activity. The coefficient of government consumption is negative in the factor growth regression, but it is positive in the TFP growth regression.

Another interesting result of these exploratory regressions is that the proxy for institutional quality has positive impacts on GDP per capita growth and TFP growth, but not on factor growth. The result suggests that better institutions' positive effects on growth are likely to be channeled primarily through improved efficiency. We will return to this point.

Table 1.7 shows that the coefficient estimates in the TFP regressions are often larger than those in the factor regressions. This implies that for equal changes in any explanatory variable, TFP growth is likely to be more sensitive than production factors growth (see Table 1.8, which shows the ratio of the estimated coefficient in the TFP regression of Table 1.7 relative to the estimated coefficient in the factor regression). Given these results, TFP growth can be expected to respond more to any given change in the explanatory variables than factor growth (except for education, life expectancy, and credit to the private sector).

Table 1.9 shows the results of multivariate regression analysis when all explanatory variables are included together. The estimated coefficients of the growth effects of the explanatory variables (first column) can be decomposed into effects on factor growth (second column) and on TFP growth (third column). In fact, our IV estimation framework yields an exact decomposition in which the first column can be obtained by simply adding the other two. Furthermore, Table 1.9 allows us to trace unambiguously the statistical significance of growth effects to one or another channel (or to both). Since we are primarily asking what drives productivity, we concentrate first on explanation of the results in the TFP equation. Later, we complement the analysis by elaborating the results of the other two equations.

The conditional convergence and cyclical reversion control variables have the expected signs, and they are statistically significant in the

Table 1.7. Individual Effects

	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP
Log of initial level	–0.0031 (1.33)	–0.0026 (2.27)**	–0.0005 (0.26)	–0.0095 (3.96)**	–0.0087 (7.88)**	–0.0008 (0.41)	0.0053 (4.28)**	0.0016 (2.67)**	0.0037 (3.81)**	0.0041 (3.34)**	0.0011 (1.85)*	0.0031 (3.09)**	0.0001 (0.06)	–0.0014 (1.58)	0.0015 (1.03)
Cyclical reversion	–0.0578 (2.78)**	0.0563 (5.45)**	–0.1141 (7.16)**	–0.0555 (2.80)**	0.0582 (6.36)**	–0.1137 (7.25)**	–0.0671 (3.36)**	0.0459 (4.73)**	–0.1131 (7.23)**	–0.0758 (3.92)**	0.0438 (4.57)**	–0.1196 (7.89)**	–0.0600 (2.93)**	0.0502 (5.17)**	–0.1102 (6.89)**
Policies															
Education	0.0100 (3.87)**	0.0054 (4.22)**	0.0046 (2.30)**												
Life expectancy				0.0968 (7.19)**	0.0685 (11.05)**	0.0283 (2.66)**									
Openness							0.0194 (6.08)**	0.0091 (5.86)**	0.0103 (4.14)**						
Imports of machinery and equipment										0.0083 (4.27)**	0.0033 (3.48)**	0.0049 (3.25)**			
Credit to private sector													0.0088 (3.60)**	0.0053 (4.59)**	0.0035 (1.83)*
Obs.	420	420	420	438	438	438	423	423	423	438	438	438	419	419	419
R^2	0.20	0.20	0.26	0.25	0.32	0.29	0.28	0.28	0.28	0.27	0.24	0.29	0.22	0.26	0.25

(*continued on next page*)

Table 1.7. Individual Effects
(continued)

	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP	GDPPC	FACTOR	TFP
Log of initial level	0.0059 (4.16)**	0.0025 (3.71)**	0.0034 (3.08)**	0.0042 (3.27)**	0.0015 (2.34)**	0.0027 (2.69)**	0.0024 (1.75)*	0.0004 (0.54)	0.0021 (1.91)*	–0.0049 (1.51)	0.0004 (0.26)	–0.0053 (2.14)**	0.0052 (4.05)**	0.0016 (2.58)**	0.0036 (3.63)**
Cyclical reversion	–0.0683 (3.27)**	0.0457 (4.58)**	–0.1139 (7.07)**	–0.0734 (3.70)**	0.0455 (4.61)**	–0.1189 (7.67)**	–0.0788 (4.02)**	0.0425 (4.37)**	–0.1213 (7.96)**	–0.0516 (2.46)**	0.0518 (5.03)**	–0.1034 (6.42)**	–0.0646 (3.16)**	0.0455 (4.63)**	–0.1101 (6.95)**
Policies															
Government consumption	–0.0065 (1.67)*	–0.0075 (3.99)**	0.0009 (0.31)												
Inflation				–0.0149 (2.75)**	–0.0015 (0.56)	–0.0134 (3.16)**									
Black-market premium							–0.0263 (3.97)**	–0.0114 (3.48)**	–0.0149 (2.89)**						
Institutions															
First principal components of ICRG										0.0060 (3.21)**	0.0004 (0.41)	0.0056 (3.93)**			
External Factors															
Terms-of-trade shocks													0.0630 (1.84)*	0.0217 (1.32)	0.0414 (1.56)
Obs.	418	418	418	416	416	416	438	438	438	367	367	367	416	416	416
R^2	0.22	0.25	0.25	0.24	0.20	0.29	0.25	0.22	0.29	0.22	0.21	0.30	0.30	0.21	0.26

Note: See Table 1.5 for definitions of variables; *t*-statistics in parentheses; year controls not shown.
*Significant at 10 percent level. **Significant at 5 percent level.

Table 1.8. Sensitivity Effects

	TFP effect/FACTOR effect
Policies	
Education	0.852
Life expectancy	0.413
Openness	1.132
Imports of machinery and equipment	1.485
Credit to private sector	0.660
Government consumption	—
Inflation	8.933
Black-market premium	1.307
Institutions	
First principal components of ICRG	14.000
External factors	
Terms-of-trade shocks	1.908

Note: Sensitivity effects are calculated as the ratio of the estimated coefficient from the TFP regression over the estimated coefficient from the FACTOR regression using the results from Table 1.7.

TFP regression. In addition, the results concerning policy-related institutional variables show that the level of openness (structure-adjusted) and the quality of institutions both have positive effects on the growth rate of TFP, and the inflation rate has a negative effect.

Trade might affect growth through different channels. For example, it might allow countries to specialize in sectors of comparative advantage, creating efficiency gains through better use of the factors of production. By expanding the size of the domestic market, trade might also allow firms to exploit sectors with economies of scale. Trade could also reduce anti-competitive practices by domestic firms, and it could limit the incentives of firms to pursue rent-seeking activities. In our results, the effects of openness on growth are channeled primarily through TFP growth. While the coefficient for the openness variable is also positive in the other two regressions, it is not significant in the factor growth regression. The result suggests that increased dynamic efficiency is the primary vehicle through which openness affects economic growth.

The inflation rate is a proxy for the quality of monetary and fiscal policy. High inflation signals macroeconomic instability that might ham-

Table 1.9. Multivariate Regression Analysis

	GDPPC	FACTOR	TFP
Log of initial GDPPC	–0.0146	–0.0086	–0.0060
	(3.49)**	(4.45)**	(1.77)*
Cyclical reversion	–0.1077	0.0064	–0.1141
	(2.47)**	(6.75)**	(6.89)**
Policies			
Education	0.0030	0.0022	0.0008
	(0.94)	(1.59)	(0.31)
Life expectancy	0.0752	0.0557	0.0195
	(4.51)**	(7.23)**	(1.44)
Openness	0.0116	0.0038	0.0078
	(2.21)**	(1.55)	(1.82)*
Imports of machinery and equipment	–0.0013	0.0014	–0.0027
	(0.42)	(1.03)	(1.11)
Credit to private sector	–0.0016	0.0005	–0.0021
	(0.57)	(0.35)	(0.90)
Government consumption	–0.0080	–0.0082	0.0002
	(1.64)*	(3.45)**	(0.05)
Inflation	–0.0117	–0.0004	–0.0113
	(2.08)**	(0.16)	(2.47)**
Black-market premium	–0.0138	–0.0086	–0.0052
	(1.71)*	(2.29)**	(0.79)
Institutions			
First principal components of ICRG	0.0047	0.0007	0.0040
	(1.82)*	(0.57)	(1.93)*
External factors			
Terms-of-trade shocks	0.0006	–0.0109	0.0115
	(0.02)	(0.72)	(0.43)
Obs.	348	348	348
R^2	0.35	0.43	0.35

Note: See Table 1.5 for definitions of variables; *t*-statistics in parentheses; year controls not shown.
*Significant at 10 percent level. **Significant at 5 percent level.

per economic growth. Our results confirm that macroeconomic policy mismanagement is associated with lower productivity growth.

The effects of institutional quality have received much attention in recent years. Acemoglu, Johnson, and Robinson (2001) show that institutions (proxied by the mortality rate of colonial settlers) have a strong causal effect on income levels. Rodrik, Subramanian, and Trebbi (2002) and Sachs (2003) show similar results using the same proxy. Barro and Sala-i-Martin (1995) used the measure of rule of law from the ICRG variables, finding a significant positive effect on the growth rate of output. However, none of these analyses clearly indicates the channel through which institutions actually affect the level of income or the growth rate. In our analysis, the coefficient for institutional quality is shown to be positive in the TFP growth regression and also in the GDP per capita growth regression. We therefore infer that if better institutions positively affect the growth rate, their effects are likely to be channeled primarily through productivity growth.

To this point, we have focused on the level of openness, the inflation rate, and the quality of institutions because these variables were shown to have a significant impact on the primary variable in which we are interested, TFP growth. We now extend our analysis by exploring results from the other variables in the regressions.

First, the coefficient for education is shown to be positive in all the regressions (although marginally significant at the 15 percent level only in the factor growth regression). The endogenous literature on economic growth generally highlights the role of human capital in long-term growth. As a factor of production, human capital has a direct role. It is also important for innovation and for the absorption of foreign technology. In growth regressions, however, proxies for human capital have not always been robust. For example, Barro and Sala-i-Martin (1995) use average years of secondary and higher education for males over 25 years old (albeit granting that not all types of educational attainment have significant impact on economic growth). Running a set of alternative econometric growth models, Loayza, Fajnzylber, and Calderón (2004) found their proxy for human capital—gross secondary-school enrollment—to have a significant positive impact on growth in about half their regressions. Our results suggest that direct impact on factor accumulation may be the main channel through which the level of human capital affects economic growth.

The life expectancy variable is found to have positive and significant effects on the output growth regression and on the factor growth regression. Life expectancy is a proxy for good health. It is normally found to be strongly related to growth according to Barro and Sala-i-Martin (1995). According to our results, this positive effect might arise through the factor accumulation channel.

In addition to our openness variable, which is a proxy for the general level of trade restriction, we specifically modeled the effect on economic growth of imports of capital goods and equipment. Imported capital goods and equipment may rely on superior technology that increases the efficiency of the production process and thus induces growth. In our results, however, this variable enters with a positive (although not significant) coefficient only in the factor growth regression. This implies that there may be only a direct effect associated with the accumulation of foreign physical capital, but no indirect effect associated with the higher level of technology embodied in these goods. It is possible, however, that our openness variable may already capture the efficiency of technologies from imported capital. When the imports of capital goods variable is entered by itself, the coefficient is positive and significant in both the factor growth regression and the TFP growth regression.

A good financial system facilitates risk diversification and channels resources that can finance productive activities. Access to credit is essential to develop investment projects. We necessarily expected a positive association between financial depth and factor accumulation. Although we did find a positive coefficient between our proxy of financial depth and the growth rate of factor accumulation, the results were not sufficiently strong to confirm a statistically significant association.

The results for government consumption are the same as when the variable enters the three regressions by itself. There is a negative effect—on factor growth and on output growth—and a positive (but not significant) effect on TFP growth. This implies that the negative effect on output growth is most likely the result of crowding-out effects on private activity, not from disruptions in productivity.

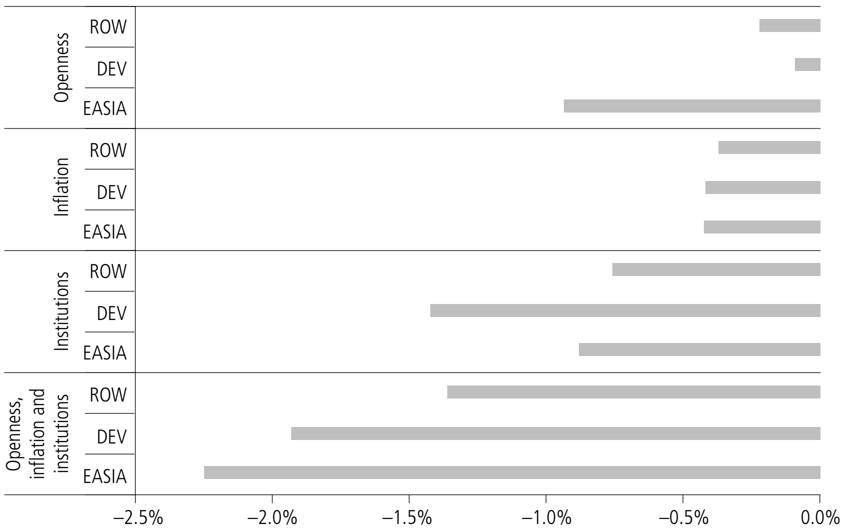
Finally, the black-market premium, like the inflation rate, is used as a proxy for poor economic policy, possibly in anticipation of crises. While higher inflation appears to be associated with lower productivity, our results suggest that repressed exchange rates are related to lower factor accumulation.

How Do These Findings Apply to the Failing TFP Growth in Latin America?

To answer this question we use the estimated equation of TFP growth in Table 1.9 to determine the role of the explanatory variables in explaining the TFP growth gap of Latin America relative to the benchmarks, which was shown to be the key to its relative performance in growth per capita over the past 40 years.

Figure 1.12 shows the contributions of the three variables with statistically significant effects on TFP growth over the long run—openness, inflation, and institutional quality—to the gap in TFP growth between Latin America and the benchmarks during 1970–99. According to the model, Latin America's performance, which was relatively worse than that of all the other regions, was the result of insufficient openness, macroeconomic

Figure 1.12. Contributions of Openness, Inflation and Institutions to Annual TFP Growth with Respect to Benchmarks, 1970–99



Note: ROW is the rest of the world; DEV is the developed countries; EASIA is East Asia.

mismanagement (proxied by the inflation rate), and weak institutions. When compared as a contribution to TFP growth with the rest of the world and with developed countries, Latin American institutional quality was the most negative. Compared with East Asia, however, the main factor was lack of openness.

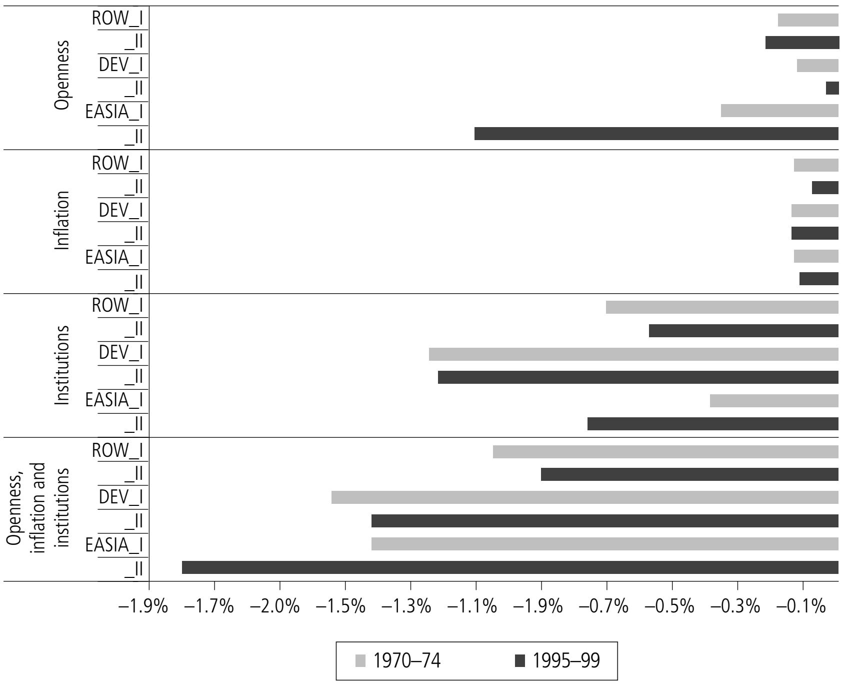
It is worth mentioning that the model is able to explain most observed gaps in TFP growth between Latin America and comparators during the selected period. Including variables of openness, inflation, quality of institutions, the convergence factor, and the cyclical factor, the model explains 98 percent of the observed gap with respect to the rest of the world, 88 percent with respect to East Asia, and 74 percent with respect to the developed countries.

The above results are based on averages over the 1970–99 period. Yet how, we might ask, did the situation evolve over time?

To answer this question, we repeated the exercise in Figure 1.12, considering the two extreme subperiods—1970–74 and 1995–99. Figure 1.13 shows the case. First, there is a shortfall in openness, macroeconomic mismanagement (as proxied by inflation), and institutional quality with respect to every benchmark in both subperiods. It is interesting to note that the relative disadvantage related to openness is more pronounced during the second period (except when compared with the developed countries). The relative disadvantage from macroeconomic management, however, is less pronounced in the second period with respect to all the regions; and the relative disadvantage from institutional quality is less pronounced in the second (except when compared with the East Asian countries).

Overall, Latin America's relative shortfalls have decreased except with respect to East Asia. Furthermore, the underlying variables that explain productivity have improved significantly. Indeed, according to our model, the average annual contribution of openness, inflation, and institutions to TFP growth during the 1995–99 period was 1.13 percent higher than the average annual contribution of these variables during the 1970–74 period. This was a significant improvement in the capacity (policy and

Figure 1.13. Contributions of Openness, Inflation and Institutions to Annual TFP Growth with Respect to Benchmarks, 1970–74 and 1995–99



Note: ROW is the rest of the world; DEV is the developed countries; EASIA is East Asia.

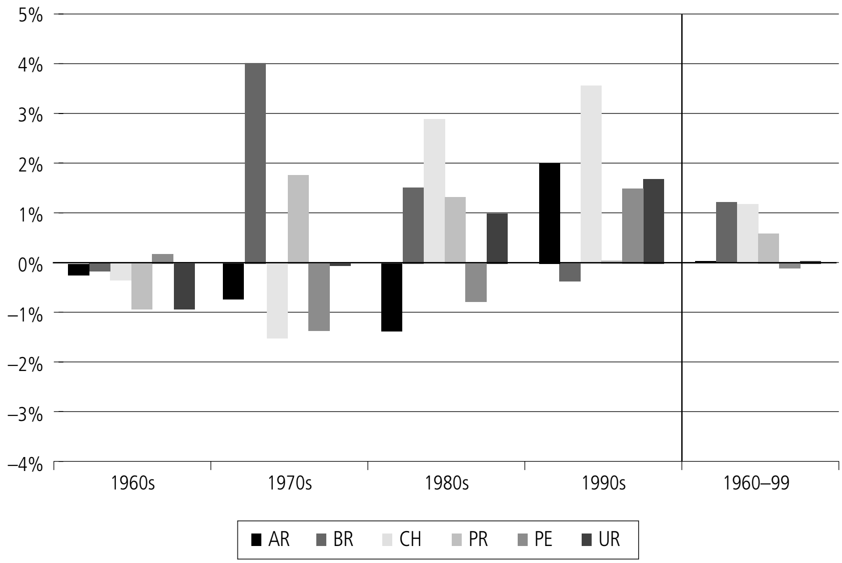
institutional) of the region to generate TFP growth; but unfortunately, it was not enough to eliminate Latin America's productivity shortfalls vis-à-vis the comparators.

Growth in Selected Countries

For perspective on the growth experience within the region itself, we now focus on the countries to be discussed in Chapters 3–8: Argentina, Brazil, Chile, Paraguay, Peru, and Uruguay. We compare their growth performances with that of the rest of Latin America and with the other benchmarks.

Figure 1.14 shows that, in general, trends in the selected countries compare favorably with the rest of Latin America in terms of per capita

Figure 1.14. Country Difference in GDP Per Capita Annual Growth versus Rest of Latin America



growth performance (as measured by decade averages). These countries generally performed better than the "typical" Latin American country during each decade. Accordingly, relative to Latin America, the selected countries (except Peru) ended up better off by the late 1990s than at the beginning of the 1960s.[19] In terms of Latin American standards, Brazil, Chile, and Paraguay significantly improved their position; Argentina, Peru, and Uruguay roughly preserved theirs (Table 1.10).

Growth performance relative to countries outside Latin America, however, is very different. Compared with the rest of the world, most of the relative growth rates are negative (Figure 1.15). The exceptions essen-

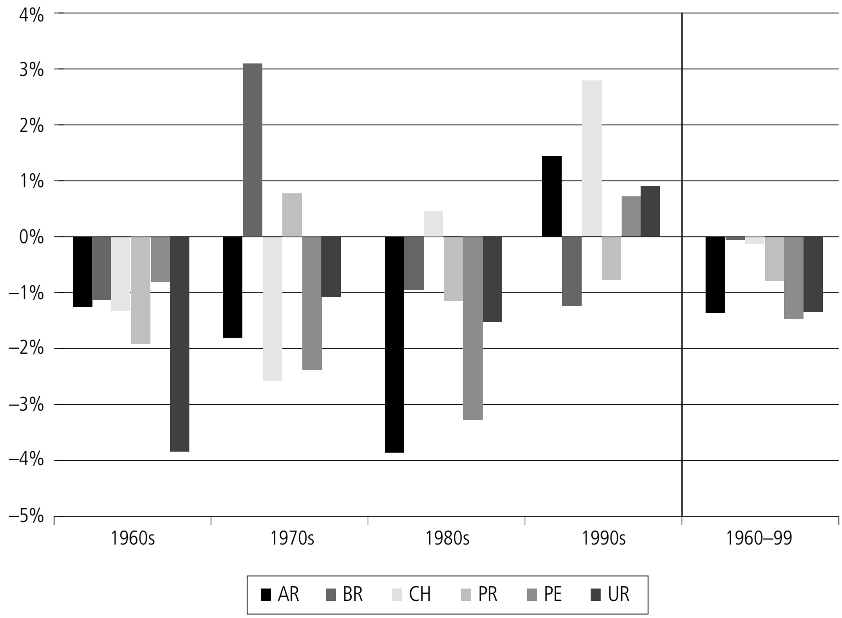
[19] It is worth noting that although the selected countries performed better than the rest of Latin America after four decades, their growth performance was significantly less stable. For example, the correlation coefficient of growth per worker in the selected countries between the first two decades (1960–79) and the last two (1980–99) is –0.52. In other words, for the countries in this group, higher-than-average growth in one period would predict lower-than-average growth in the other! This compares to a positive correlation of 0.55 for the rest of Latin America.

Table 1.10. Country Income Per Capita Relative to Rest of Latin America *(in percent)*

	1960–62	1997–99
Argentina	258	259
Brazil	105	175
Chile	168	262
Paraguay	68	87
Peru	121	109
Uruguay	221	237

Note: Based on real GDP per capita (PPP).

Figure 1.15. Country Difference in GDP Per Capita Annual Growth versus Rest of World



tially coincide with the very best decade for each selected country: the 1970s for Brazil and Paraguay and the 1990s for Argentina, Chile, Peru, and Uruguay. Overall, when we consider the entire 1960–99 period, each and every selected country experienced a per capita income decline with respect to the rest of the world, even in spite of the stellar performances of Brazil in

Table 1.11. Country Income Per Capita Relative to Developed Countries
(in percent)

	1960–62	1997–99
Argentina	76	43
Brazil	31	29
Chile	49	43
Paraguay	20	14
Peru	35	18
Uruguay	65	39

Note: Based on real GDP per capita (PPP).

Table 1.12. Country Difference in Average Annual Growth versus Rest of Latin America, 1960–99
(in percent)

	GDP per capita growth	Labor/Pop	Skills	Capital/Labor	TFP
Argentina	–0.02	–0.43	0.00	0.12	0.29
Brazil	1.32	0.30	–0.16	0.17	1.00
Chile	1.21	0.00	–0.17	0.37	1.00
Paraguay	0.61	–0.32	–0.11	0.94	0.10
Peru	–0.11	–0.08	0.21	–0.22	–0.02
Uruguay	0.03	–0.18	–0.19	–0.18	0.59

the 1970s and Chile in the 1990s. In particular, the substantial gap in per capita income vis-à-vis the United States and the typical developed country (Table 1.11) widened further during the past four decades. The selected Latin American countries became relatively poorer by international standards.

To account for faster growth (excepting Peru) relative to the rest of Latin America between 1960 and 1999, we examined underlying contributing factors to growth performance (Table 1.12). In each case (and precisely, with the exception of Peru), productivity grew faster. Indeed, productivity growth was their comparative advantage relative to the rest of Latin America (except accumulation of capital in the case of Paraguay). In addition to

Table 1.13. Country Difference in Average Annual Growth versus Rest of World, 1960–99
(in percent)

	GDP per capita growth	Labor/Pop	Skills	Capital/Labor	TFP
Argentina	–1.39	–0.19	0.05	–0.27	–0.98
Brazil	–0.06	0.54	–0.11	–0.22	–0.27
Chile	–0.17	0.24	–0.12	0.02	–0.27
Paraguay	–0.77	–0.07	–0.07	0.55	–1.17
Peru	–1.49	0.16	0.26	–0.61	–1.29
Uruguay	–1.35	0.06	–0.15	–0.58	–0.68

productivity growth, they gained ground intraregionally in the deepening of physical capital (excepting Uruguay), but they lost ground in skills.[20] By contrast, Peru mirrors these general trends negatively: productivity and physical capital grew more slowly to produce lower growth despite gains in skills.

Next, we examine factors underlying slower relative growth in the selected countries (Table 1.13). The lack of TFP growth was very important during 1960–99—in fact, the dominant factor—in accounting for both the slower growth and the widening gap between these countries and the rest of the world.

A similar picture emerges from comparison of factors and average annual growth rates vis-à-vis the sample of developed countries (Table 1.14).

In short, what appeared to be strength within Latin America turns out to be weakness from the perspective of the world. Total factor productivity growth in the selected countries compared favorably to the rest of Latin America only because of the dismal (negative) productivity performance in the rest of the region. The selected countries fell behind the world's performance because of low total productivity growth. The only important

[20] The growth rate of TFP in the selected countries was more unstable than in the rest of Latin America. Their larger instability of TFP is the main factor behind the larger instability of the growth rate of GDP per capita that we reported in the previous footnote.

Table 1.14. Country Difference in Average Annual Growth versus Developed Countries, 1960–99
(in percent)

	GDP per capita growth	Labor/Pop	Skills	Capital/Labor	TFP
Argentina	–1.52	–0.36	0.20	–0.30	–1.07
Brazil	–0.19	0.37	0.05	–0.25	–0.35
Chile	–0.30	0.07	0.03	–0.05	–0.35
Paraguay	–0.90	–0.25	0.09	0.51	–1.25
Peru	–1.62	–0.01	0.42	–0.65	–1.38
Uruguay	–1.48	–0.11	0.01	–0.61	–0.77

gains relative to the rest of the world (that is, more than 0.2 percent in annual growth) are explained by Paraguay's exceptional physical investment in hydroelectric dams, higher labor participation in Brazil and Chile, and higher accumulation of skills in Peru.

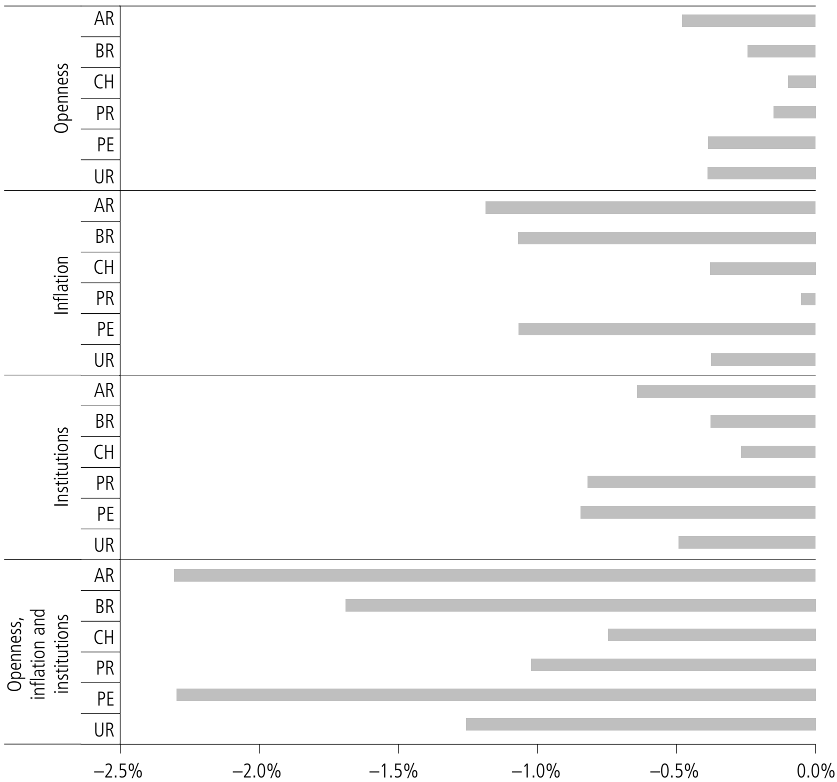
Finally, we apply the econometric model from the previous section to determine the role of the explanatory variables in explaining the TFP differences between the selected countries and the benchmarks. Figure 1.16 shows the contributions of openness, inflation, and institutions to the TFP difference in growth from 1970 through 1999.

According to the model, the selected countries' relatively worse performance versus the rest of the world resulted from all factors—lack of openness, policy mismanagement (inflation), and inferior institutions. Policy mismanagement was the main factor in Argentina, Brazil, Chile, and Peru. Inferior institutions were the main factor in Paraguay and Uruguay.

How Are These Shortfalls Evolving?

We now repeat the exercise in Figure 1.16, considering the subperiods 1970–74 and 1995–99. Figure 1.17 shows the results. The relative disadvantage from openness increased in the second period (except for Paraguay). The relative disadvantage from inflation decreased (except for Paraguay and Peru). The relative disadvantage from inferior institutions decreased in Chile and Paraguay during the second period, but it increased in Brazil, Peru, and Uruguay.

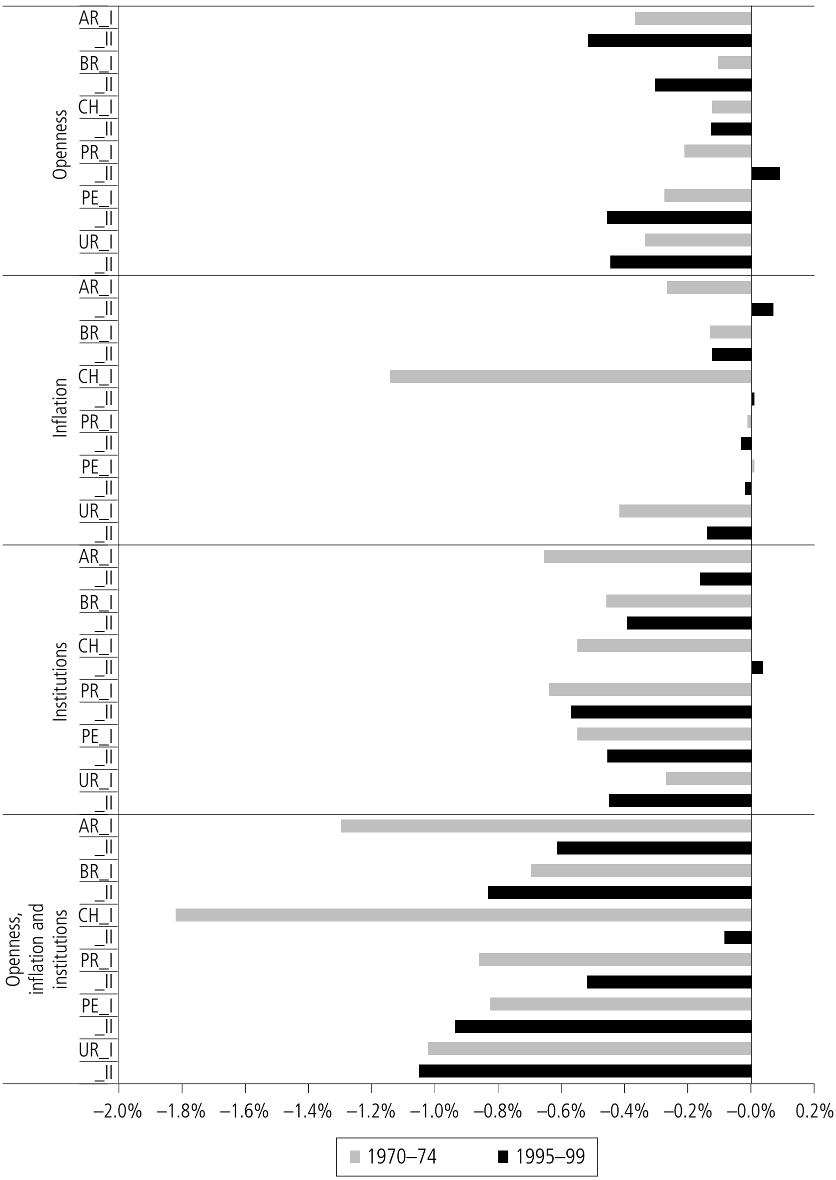
Figure 1.16. Contributions of Openness, Inflation and Institutions to Annual TFP Growth versus Rest of World, 1970–99



Conclusion

In this chapter we have provided an overview of the growth experience of Latin America during the last four decades. At first glance, the typical country in Latin America appears to have made good progress overall (increasing income per capita) but fallen into a low growth pattern during the 1990s, failing to regain the dynamism of the golden 1960s and 1970s. We find that this message is profoundly misleading. We argue that growth performance ought to be evaluated in relation to growth opportunities. When growth in Latin America is compared to relevant benchmarks derived from growth in the rest of the world, which control for world technology shocks, we find

Figure 1.17. Contributions of Openness, Inflation and Institutions to Annual TFP Growth versus Rest of World, 1970–74 and 1995–99



that the typical country in Latin America has grown more slowly over the period and that the 1990s is actually the best decade. Countries in Latin America had subpar growth in the 1960s and 1970s; relative to that, growth in the 1990s was an improvement.

The six countries highlighted in Chapters 3–8 of this volume follow the broad pattern described for the typical Latin American country, with the exception of Brazil's very high growth in the 1970s. Yet despite their faster growth within the region (excepting Peru), each selected country saw its per capita income decline relative to the outside benchmarks, including Brazil and Chile with their stellar performances in the 1970s and 1990s, respectively.

TFP, rather than factor accumulation, stands out as the key to explaining these growth gaps. Differences in growth rates of labor participation or the accumulation of capital (human capital in the form of labor skills and physical capital in the form of capital per worker) typically pale in importance when compared with the gaps or reversals from lagging productivity improvement. In turn, this failure in productivity can be traced to distortions in the economy that drive aggregate efficiency below the technological frontier.

Our analysis of the gaps in per capita income also points to a failure in TFP. Relative to the typical developed country, income per capita declined from 37 percent in the 1960s to 24 percent in the 1990s. Despite conventional wisdom to the contrary, the main problem was not education. If labor skills were the only difference, the typical Latin American country would have Spain's income (or 80 percent of the typical developed country's income), and it would be improving. Physical capital intensity is significantly subpar, though it is broadly in line with the available returns to investment. Better financial conditions would certainly help, but per capita income would nevertheless increase to 31 percent at most—not enough to recover what was lost during the period. By contrast, closing the productivity gap would have a direct static effect on income and an indirect effect on investment. The corresponding higher returns would bump per capita income to 59 percent at least, a level above Portugal's or Greece's.

This policy focus on total factor productivity is further confirmed by contrasting the structure of production factors in Latin America with what could be expected under normal development. We find that the current structure of the aggregate production function in Latin America is normal, which we interpret as meaning that there is no anomalous relative shortfall in labor skills or physical capital that calls for policy priority. In fact, the collapse of productivity over time can be interpreted as an adjustment that eliminated excess productivity (relative to too little human and physical capital). While the policy priority in the 1960s could have been factor accumulation to exploit high productivity, right now policy attention ought to be directed to productivity.

We find that the key policy instruments to address failures in total factor productivity are openness with the rest of the world, quality of macroeconomic policies, and quality of institutions. Shortfalls in these aspects go a long way in explaining the opening gaps in productivity and, consequently, in overall growth. We find that macroeconomic stability and institutional gaps are gradually closing but the gap in openness is not, which suggests that an effort toward accelerating economic integration is high priority.

Appendix 1.A

Data Sources

GDP	Penn World Table 5.6, Easterly and Levine (2001), and World Development Indicators
Capital	Penn World Table 5.6, Easterly and Levine (2001), and World Development Indicators
Labor force	World Development Indicators
Years of education	Barro and Lee database
Life expectancy	World Development Indicators
Openness	Authors' construction using World Development Indicators data
Inflation	Global Development Finance and World Development Indicators
Black-market premium	Easterly and Levine (2001)
Credit to private sector	World Development Indicators
Government consumption	World Development Indicators
Imports of machinery	UN Commodity Trade Statistics Database
Terms of trade	Global Development Finance and World Development Indicators
Institutional variables	International Country Risk Guide

Appendix 1.B

Measures of Total Factor Productivity

The labor and capital data employed in the growth accounting exercises of this chapter refer to the inputs that are "available" in the marketplace rather than the inputs "effectively used" in the economy. In this appendix we explain how this is consistent with a broad definition of total factor productivity. Consider the following production function:

$$Y = K_u^{\alpha}\left(h_u L_u\right)^{1-\alpha} A_u, \tag{1.B.1}$$

in which K_u and $h_u L_u$ are the capital and labor inputs effectively utilized in the production process, and A_u is the corresponding observed productivity. Denoting the levels of available capital and labor inputs as K and hL respectively (L being unskilled labor and h its average skill level), we can use the expressions

$$K_u = K\frac{K_u}{K}\ ;\ L_u = L\frac{L_u}{L}\ ;\ h_u = h\frac{h_u}{h}$$

to rewrite equation (1.B.1) as follows:

$$Y = \left(K\frac{K_u}{K}\right)^{\alpha}\left(h\frac{h_u}{h}L\frac{L_u}{L}\right)^{1-\alpha} A_u. \tag{1.B.2}$$

In growth rates, equation (1.B.2) becomes

$$\left(\hat{Y}\right) = \alpha\left(\hat{K}\right) + \alpha\left(\frac{\hat{K}_u}{K}\right) + \left(1-\alpha\right)\left(\hat{h}\right) + \left(1-\alpha\right)\left(\frac{\hat{h}_u}{h}\right) + \left(1-\alpha\right)\left(\hat{L}\right) + \left(1-\alpha\right)\left(\frac{\hat{L}_u}{L}\right) + \left(\hat{A}_u\right). \tag{1.B.3}$$

From this expression, it can be seen that the growth rate of output depends on the growth rate of the available inputs and skills $(\hat{K})$, $(\hat{L})$, $(\hat{h})$, the growth rate of the utilization of these inputs and skills $(\hat{K}_u/K)$, $(\hat{L}_u/L)$, $(\hat{h}_u/h)$, and the growth rate of productivity $(\hat{A}_u)$.

The productivity variable in this specification is not affected by changes in factor utilization rates. This productivity variable only reflects changes in aggregate "technology" springing either from changes in efficiency at the micro level or from changes in the efficiency of the overall economic environment in which the production takes place. We like to think about efficiency, however, in a broader sense, taking into account the additional output that would be obtained if available inputs that are not channeled into the production process were utilized. We view idle input resources as a form of inefficiency and want to measure it accordingly. To achieve this, we want to measure TFP relative to potential output under full utilization of inputs available in the marketplace.

For example, consider two economies, A and B, with the same endowments and technology. Country A, however, exhibits a larger unemployment rate. We like to think of country A as being less efficient than country B because it produces less with the same amount of available resources. Growth accounting exercises based on the amount of inputs used (rather than the amount of inputs available) will conclude that the productivity of both countries is the same, thereby failing to capture this type of inefficiency. The productivity variable will only capture this inefficiency if the growth accounting exercises are based on the amount of inputs available. To see this, consider the following production function:

$$Y = K^{\alpha}\left(hL\right)^{1-\alpha} A. \tag{1.B.4}$$

Here, K and hL represent the levels of inputs of capital and labor "available" in the economy. Expressing equation (1.B.4) in growth terms and solving for the growth rate of productivity gives the following:

$$\left(\hat{A}^*\right) = \left(\hat{Y}\right) - \alpha\left(\hat{K}\right) - (1-\alpha)\left(\hat{h}\right) - (1-\alpha)\left(\hat{L}\right) \tag{1.B.5}$$

Finally, using equation (1.B.3) to substitute for $\hat{Y}$ in this expression results in

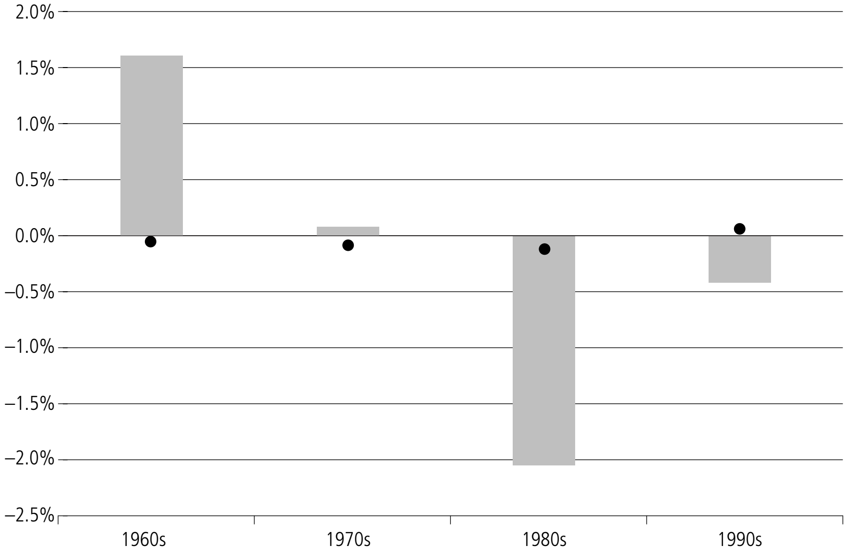
$$\left(\hat{A}\right)=\left(\hat{A}_u\right)+\alpha\left(\frac{\hat{K}_u}{K}\right)+\left(1-\alpha\right)\left(\frac{\hat{h}_u}{h}\right)+\left(1-\alpha\right)\left(\frac{\hat{L}_u}{L}\right). \tag{1.B.6}$$

Expression (1.B.6) shows that the growth rate of productivity $\left(\hat{A}\right)$ depends on the growth rate of "technological" change $\left(\hat{A}_u\right)$ and the growth rates of factor utilization of capital $\left(\hat{K}_u/K\right)$, labor $\left(\hat{L}_u/L\right)$, and skills $\left(\hat{h}_u/h\right)$. Therefore, for example, if an economy exhibits an increase in the rate of unemployment, that is, $\left(\hat{L}_u/L\right) < 0$, this will be captured as lower productivity growth $\left(\hat{A}\right)$.

Understandably, there are changes in the utilization of inputs along the economic cycle. Economies tend to use more or less inputs depending on which phase of the cycle they are in. Therefore, it would be misleading to judge an economy as less efficient just because it is in a lower part of the cycle. The issue of factor utilization becomes important only if there are differences in long-run trends. Consequently, in our growth accounting exercises we use 10-year averages to smooth out changes in the utilization of inputs due to the cycle.

Following equation (1.B.6), we used data on employment and the labor force to measure the size of the contribution of the utilization of labor $\left(1-\alpha\right)\cdot\left(\hat{L}_u/L\right)$ on the growth rate of productivity $\left(\hat{A}\right)$. We show that in general this contribution is rather small (see Figure 1.B.1). An immediate implication of the smallness of these contributions is that the results and conclusions of this chapter, which is based on the analysis of decade averages, do not change qualitatively if we adjust for the rate of unemployment.

Figure 1.B.1. TFP Growth and Contributions from Changes in Labor Utilization by Decade



Note: Dots represent contributions from labor utilization.

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CHAPTER 2

Growth in Latin America: Empirical Findings and Some Simple Theoretical Explanations

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Performance of the Latin American economies was disappointing during the 20th century. Using per capita GDP as a measure, Latin America roughly maintained its income relative to the world over the past hundred years; but if only post-1950 performance is considered, results are more discouraging. Using data from Maddison (2003), Latin American income per capita was 18 percent higher than the world average in 1950. Thirty years later, it still exceeded the world average by almost 20 percent. But by the early 1990s, Latin American per capita income had declined relatively to roughly the world average; and over the past 15 years, it has not improved.

Though not the only region of the world that underperformed—Africa's performance, for example, was even worse—Latin America's failure stands out because of its plentiful endowment of natural and human resources; its institutions; and relative to much of the rest of the world, its relatively low level of social conflict. Rather than an underperformer, Latin America *should have been* one of the 20th century's high-growth regions. Since it wasn't, what explains the divergence between seemingly reasonable expectations and actual outcomes? What in fact were the determinants of growth in Latin America?

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This chapter has two objectives. First, using the results from individual country studies and from regional analyses, I discuss the proximate reasons for Latin America's poor economic performance. I summarize the major findings from both the growth and development accounting exercises, allocating differences in output per capita (or its growth rate) to differences in factor inputs and to total factor productivity (TFP). Generalizing from the sample of countries included in this study is not easy. However, it is clear that physical and human capital input accumulation have proceeded at a steady pace over the past 50 years. On the other hand, measured TFP has been far less stable. Of particular interest, TFP decreased during the so-called Lost Decade of the 1980s. This suggests that TFP cannot be viewed simply as a measure of technology. For this reason, the individual country studies (Chapters 3–8) and the thematic regional analyses (Appendices A–D) in this volume explore how TFP is affected by real and policy shocks. While the details may vary across periods and from country to country, virtually all studies demonstrate that policies—in particular, *bad* ones—negatively influenced measured productivity.

The second objective of the chapter is to explore the channels through which real and policy shocks affect TFP. I argue that "standard" distortions—for example, simple wedges created by distortionary taxes—cannot account for changes in TFP. Distortions affect factor accumulation, not measured productivity. It is therefore necessary to consider more complex kinds of distortions that imply, effectively, that the economy is in the interior of the production possibilities set. On the other hand, we might alternatively postulate no inefficiencies. In this case, movements in TFP could merely be a measurement problem. The relevance of each kind of distortion affecting factor accumulation—whether simple or complex—cannot be determined theoretically. It is necessary to fully specify models, and then test them with data. This chapter begins this process, sketching out some potentially promising avenues for further research.

The chapter is organized into four major sections. The first discusses major findings on the evolution of TFP and the role of factor accumulation. The second presents a series of simple theoretical models to help in understanding the connection between shocks, TFP, and factor accumulation. The third summarizes the results of the country studies in Chapters 3–8; and the final section offers some concluding comments.

Findings

Contributions to this volume—the aggregate analysis by Blyde and Fernández-Arias, the six country studies, and the four thematic background papers—use a range of methods to study the major determinants of growth in Latin America; yet reading across the findings reveals consistent regularities. It is convenient to distinguish between the role played by factor accumulation and productivity (in an accounting sense) and the impact of real and policy shocks on the same set of variables.

From a purely accounting point of view, differences and changes in aggregate output can be decomposed simply into changes in the quantities of inputs used and a residual element that captures (as a first approximation) movements in the efficiency in the use of resources, or TFP.[2]

To formalize this decomposition, assume an aggregate production in the form of

$$Y_t = A_t K_t^{\alpha} \left(e^{h_t} L_t\right)^{1-\alpha}, \tag{2.1a}$$

in which K_t is the capital stock, L_t is the number of hours employed (or number of individuals employed if hours variation is unimportant), and h_t measures human capital. It follows that

$$\ln\left(Y_t/P_t\right) = \frac{1}{1-\alpha}\ln\left(A_t\right) + \frac{\alpha}{1-\alpha}\ln\left(K_t/Y_t\right) + \ln\left(L_t/P_t\right) + h_t, \tag{2.1b}$$

in which P_t is population at time t. According to this specification, changes in output per capita are due to changes in the capital intensity of production (as measured by K/Y), changes in the labor force participation rate (as

[2] Since TFP is a residual, it is not easy to interpret. Given how it is measured, it includes the effects of technology, as well as resulting distortions in an economy operating in the interior of the production possibilities frontier.

measured by L/P), changes in the average level of human capital, h, and changes in the residual (or TFP), A.

More precisely, if γ_x denotes the growth rate of variable x, and assuming constant growth rates, it is possible to rewrite the previous expression as

$$\gamma_{Y/P} = \frac{1}{1-\alpha}\gamma_A + \frac{\alpha}{1-\alpha}\gamma_{K/Y} + \gamma_{L/P} + \gamma_h. \tag{2.2}$$

This expression shows that the growth rate of per capita output can be decomposed by its sources: changes in inputs $\gamma_{K/Y}$, $\gamma_{L/P}$, and γ_h, and changes in TFP (γ_A). To operationalize either formula, good measures of inputs and α are necessary. If factors are paid their marginal products, α corresponds to the share of capital payments in GDP.

The authors of the individual country studies paid significant attention both to the estimation of the appropriate measures of inputs (quality-adjusted levels of capital and labor) and to the choice of the best value of α.[3] Their findings suggest values of α ranging from 0.3 to 0.7. The high values tend to reflect measured (in the National Income and Product Accounts) capital income. Gollin (2002), however, argues that problems in measurement may require that the estimate of the capital share be adjusted downward. Since most of the country studies decomposed total growth using a value of α equal (or close) to 0.3, I will base my comments on that particular decomposition.

The Evolution of TFP

This section discusses some findings on the factors that influence TFP at a general level. For analyses of these effects in specific countries, see the country case studies.

- *The Contribution of TFP*. For the majority of the countries in the sample, the contribution of TFP, defined as

[3] For an early and comprehensive analysis as applied to some Latin American countries, see Elías (1992).

$$\left(\frac{1}{1-\alpha}\gamma_A\right)\Big/\gamma_{Y/P},$$

is significant. Even in countries such as Chile, where this effect is not large on average, the importance of TFP is evidently magnified in periods of high growth in output per capita. These results can be extrapolated to the "typical" Latin American country, as shown by Blyde and Fernández-Arias (Chapter 1) and De Gregorio and Lee (Appendix A). Moreover, the variance of measured TFP accounts for most of the variance in growth rates.

- *Movements in TFP*. In most Latin American countries, the growth rate of TFP until the mid- to late 1970s was positive and relatively small. From then until the early 1990s—including, in particular, the Lost Decade of the 1980s—the level of TFP dropped sharply. In the 1990s, the picture was more mixed. In countries such as Argentina and Chile, measured TFP increased at exceptionally high rates; while in countries such as Brazil and Peru, the increase was modest. In some cases—for example, Uruguay and Paraguay—TFP decreased in the 1990s. Relative to the rest of the world, Latin American countries lost productivity in every decade since 1960. However, when TFP is examined in the context of global trends, the 1960s and 1970s look very similar to the 1990s. The 1980s are still a poorly performing decade (Blyde and Fernández-Arias, Chapter 1).
- *Policies and TFP*. The data do not support the interpretation that changes in A_t reflect exogenous changes in productivity. First, under this interpretation, a decrease in TFP is equivalent to assuming that firms somehow "forget" how to use a technology efficiently from one period to the next. Second and more to the point, country studies demonstrate that policy changes correlate with changes in TFP. It is sometimes easy to document this correlation. For example, TFP appears to be correlated with the relative price of capital goods, with measures of the real exchange rate and the domestic inflation rate, as well as size-of-govern-

ment measures such as the ratio of government consumption to output. These findings are consistent with the view that changes in the trade regime (as proxied by the first two variables) and changes in the level of domestic distortions (as proxied by the other two) can affect measured TFP. These examples, however, do not completely exhaust findings on the relationship between policies and TFP. During periods of economic liberalization—for example, Chile in the late 1970s and post-1985, and Argentina and Peru in the 1990s—TFP tended to increase significantly above trend. This observation does not apply uniformly to every country study—for example, Uruguay and to some extent, Brazil in the 1990s. The difficulty in assessing the impact of major policy reforms is that they typically include structural shifts. The short- and long-term effects of policy changes such as privatization and deregulation are by no means easy to evaluate in the absence of explicit models and given the small amount of available data. In their overview of Latin American countries, Blyde and Fernández-Arias (Chapter 1) find three variables that primarily determine the growth rate of TFP—measure of openness (positive), quality of institutions (positive), and inflation rate (negative). It is thus safe to conclude that studies in this volume support the view that TFP is not exogenous. Rather, TFP growth appears more closely related to changes in government policies, technology, and price shocks, as well as to institutional quality.

- *Real Shocks and TFP*. Country studies such as Chile, Peru, and Uruguay find that periods of deteriorating terms of trade and of shocks to the real exchange rate are also periods in which measured TFP changes substantially. In other instances, economic shocks to a neighboring country—a shock that is similar in some respects to a movement in terms of trade—also appear to feed back to affect measured TFP. This is illustrated by the cases of Uruguay and Paraguay. As in the case of policies, generalization is risky here because the individual studies in this volume did not employ a common methodology. Nevertheless, it appears that to successfully explain growth in Latin America, an analytical framework would have to account for the impact of technology and terms-of-trade shocks on measured TFP.

- *TFP and Inputs*. Most country studies find high correlation between TFP and the level of capital and labor. In general, the movements are not proportional. Thus, when TFP increases rapidly, capital grows more slowly; and when productivity declines, capital fails to decrease at the same rate. The correlation between TFP and human capital—at least when proxied by education—is weaker. This variable displayed an upward trend, even during the low TFP decade of the 1980s.

The Role of Factor Accumulation

It is natural to begin analysis with the view that policies (and shocks) are major determinants of economic performance. Both policies and shocks affect the extent to which factors are used in production. They also affect the productivity of factors. In the previous section, I described findings on the relationship between policies (shocks) and movements in TFP. In this section, I present results on the impact of policies on factor.

Over the past four decades, we see substantial variability in policies corresponding to both changes over time for given countries (the time-series dimension) and differences across countries (the cross-section dimension).

Analyzing the effects of policies and shocks for a sample of Latin American countries, Blyde and Fernández-Arias (Chapter 1) find that the growth rate of factor accumulation depends negatively on the level of output per capita, a standard convergence effect. They also find that deviations from the trend value of TFP—which also serves as a measure of cyclical variation—positively affect factor accumulation. Thus, evidence from Latin American economies suggests the presence of convergence effects. In other words, a catch-up effect is at work in which periods of low factor accumulation are likely to be followed by periods of relatively high factor use.

In addition to the transition effects, Blyde and Fernández-Arias find that growth in the factor component of output is positively associated with the following variables: improvements in human capital (as measured by increase in life expectancy), lower levels of government consumption (relative to output), and reduction in the black-market premium (probably correlated with poor overall economic policies). Their findings are consistent with the view that domestic policies have causal effects on resource accumulation. Consider, for example, a policy measure that increases life expectancy. This can be viewed as an action more or less equivalent to increasing individual planning horizons. In most models of human capital accumulation, this results in increases in the demand for schooling and training. On the other hand, a high ratio of government consumption to output is likely to be associated with high levels of distortion, which in turn reduces both physical and human capital accumulation. Finally, the black-market premium is also an indicator of policy instability in that it signals the market's view that the price of foreign exchange set by the government is unsustainable. As will be argued in the following section, policy instability induces some firms to postpone implementation of investment projects, thus resulting in lower investment. Another interesting result is that Blyde and Fernández-Arias find no effects associated with standard policy variables such as openness and inflation, and even institutional quality is not significant in explaining the rate at which factors are accumulated.

In the past 50 years, most Latin American countries have made substantial progress in educational attainment and improved access to and quality of health care. It is not immediately obvious how to translate improvements in education and health attainment into changes in the stock of human capital. Yet whether the improvements can be precisely measured or not, better educated and healthier workers can be expected to be more efficient.[4] In general, time-series data show a rising stock of human capital. Gains continued even in the 1980s, a period when regional per

[4] For a discussion on the connection between schooling and the quality of human capital in the context of dynamic models of development, see Manuelli and Seshadri (2005).

capita growth was otherwise negative. In the 1990s, the rate of increase in the stock of human capital decelerated; and in some cases, it even turned negative.

It is not easy to find a simple relationship between economic policies and schooling and health care decisions. The Latin American experience indicates that poor economic policies have not discouraged human capital accumulation. Even more puzzling, the 1990s witnessed a number of major policy reforms that aligned private incentives with marginal costs, yet these regime changes evidently did not increase the rate of human capital formation.

The behavior of capital is difficult to summarize. From 1950 to 1980, capital-output ratios increased moderately in most Latin American countries. This is consistent with long-term decline in the relative price of capital goods, as described by Gordon (1990). But in this light, the past two decades present an unclear picture. During the 1980s, the capital-output ratio steadily *increased* in most countries (though at more moderate rates where output was stable or decreasing). But in the 1990s, many countries experienced substantial *decreases* in capital-output ratios even while their economies were expanding.

Can this behavior be explained by changes in prices or policies? During the 1980s, the interest rates on international borrowing rose for most countries. This in turn translated into fairly high domestic interest rates. In addition, several countries adopted trade policies that effectively increased the price of capital. The combination of these two effects worked toward a *lower* capital-output ratio in the 1980s. At least two arguments might explain why. First, in a world in which TFP is viewed as stochastic, a negative (positive) shock to TFP results in a higher (lower) level of capital per unit of output (see section on simple models). Since the 1980s were a decade of unusually low TFP, and the 1990s a decade of high TFP, this could help resolve the puzzle. A second argument has to do with levels of public investment. If a government increased public investment in response to the weak economic conditions in the 1980s and then compensated for that increased investment in the 1990s (a period in which "smaller government" policies were widely adopted), then it is possible that the capital-output ratio moved in agreement with the observations. (For a more formal argument, see the following section on simple models.)

A final theme from the country studies is that uncertainty over the economic environment contributed to lower output. In cases such as Peru, economic policy fluctuated between fairly extreme values. Overall, the average duration of a regime was less than six years. Uncertainty over future economic conditions—even when it does not affect the price of capital goods—results in less investment in physical capital.

Simple Models

In this section, I present a series of simple models that shed light on mechanisms that can explain the effects of policy changes and exogenous shocks on TFP and factor accumulation. The presentation is not rigorous. The objective is to provide a somewhat formal intuition about the channels through which policies affect measured TFP and the equilibrium levels of capital and labor.

Policies, Shocks, TFP, and Resource Accumulation

As indicated above, a simple model of growth can be summarized in the growth accounting relationship

$$\ln\left(Y_t/P_t\right) = \frac{1}{1-\alpha}\ln\left(A_t\right) + \frac{\alpha}{1-\alpha}\ln\left(K_t/Y_t\right) + \ln\left(L_t/P_t\right) + h_t. \qquad (2.3)$$

In a standard growth setting, TFP is interpreted as a measure of (exogenous) productivity. However, as mentioned above, this interpretation is difficult to reconcile with evidence that indicates that the level of TFP can decrease by about 10 to 20 percent over a decade or so. A broader explanation of TFP is needed.

A natural first approach is to posit that policies are influencing TFP. This is consistent with the evidence and also appealing from a theoretical point of view. Unfortunately, standard models of distortions are *inconsis-*

tent with this view. By way of illustration, it is useful to consider a steady state in which population and employment are stationary, and A (the "true measure" of productivity) is constant. Given an interest rate r and a tax rate on the returns to capital equal to τ,[5] standard profit maximization implies that

$$(1-\tau)\alpha AK^{\alpha-1}\left(e^{h}L\right)^{1-\alpha}=p_k(r+\delta), \tag{2.4}$$

where p_k is the price of capital goods and the term

$$\frac{p_k(r+\delta)}{1-\tau}$$

is a measure of the user cost of capital.

The previous expression shows that increases in the tax rate decrease the stock of capital per worker and the level of per capita output. If the above expression is rearranged, the capital-output ratio is given by

$$\kappa \equiv \frac{p_k K}{Y}=\frac{\alpha(1-\tau)}{(r+\delta)}. \tag{2.5}$$

It follows from the formula that not all increases in the user cost of capital translate into lower capital-output ratios—in particular, that changes in the price of capital goods have no impact on κ.[6] This extreme result reflects the assumption that, first, the price of capital is constant, and second, the same price is used in computing the capital stock. Though these assumptions may be reasonable for certain long-term applications, they are not when trying to use the model to explain short-term changes in κ.

To study the effect of shocks and uncertainty, I assume that during period t individuals form expectations about future productivity shocks

[5] The results are similar when more realistic tax codes are taken into account.

[6] In this discussion, the capital-output ratio is measured in domestic prices. If κ is measured at international prices instead, then changes in the wedge between domestic and international prices of capital—because of tariffs, for example—influence the measured capital-output ratio.

and the prices of capital goods.[7] The appropriate version of the optimality condition is

$$p_k(1+r)-(1-\delta)E[p_k']=(1-\tau)\alpha E[A']K^{\alpha-1}(e^hL)^{1-\alpha}, \tag{2.6}$$

in which the prime symbol (′) indicates a future value and the symbol E denotes the conditional expectation. Note that, given the current price of capital goods (p_k), an increase in the expected future price $E[p_k']$ reduces the user cost of capital; and this induces higher levels of investment. The reason for this is simple: the expected price increase creates the possibility of a windfall for the owner of capital, which serves as an incentive to purchase capital goods.

A simple manipulation of the above expression shows that the observed capital-output ratio is given as

$$\kappa \equiv \frac{p_k^B K'}{Y'} = \frac{E[A']}{A'} \frac{p_k^B(1-\tau)}{p_k(1+r)-(1-\delta)E[p_k']}, \tag{2.7}$$

in which p_k^B is the (constant) price used to compute (in the National Income and Product Accounts) the real level of investment. This simple formula reveals some interesting effects. First, if the realized value of TFP (A') is lower than the expected value $(E[A'])$, κ increases. This might be called a "recession effect." In other words, if investment plans were made when expectations for future output exceeded actual output, decision makers would have found themselves with "unwanted" excess capital. Of course, this effect can explain some short-run changes in κ; but it is less likely to explain decade-long variations unless there are long gestation lags.

The capital-output ratio may increase even in periods of increasing capital goods prices. This would be the case if increases in p_k are associated with (sufficiently large) increases in $E[p_k']$, so that the denominator of (2.7) decreases. This situation might occur in anticipation of a change in gov-

[7] I focus on uncertainty over these two variables in order to simplify presentation. A more complete model would also take into account the covariation between shocks and interest rates.

ernment policy that results in higher prices of capital goods—in which case, the private sector responds to moderate increases in prices with increased investment.

Even though shocks to the price of capital goods, actual TFP, and interest rates are likely to substantially affect measures such as the capital-output ratio and the equilibrium level of labor, they do not affect measured TFP. If these were the only shocks hitting Latin American economies and *if* our simple model captured all relevant features of the economic environment, TFP and technology might logically be expected to be the same. Yet this implication is at odds with our finding—not only that TFP is important in explaining growth, but that it is not exogenous because it is influenced by policy and technology shocks. Thus, to borrow from Prescott (1998), we need a theory of Total Factor Productivity. In the following discussion, I set forth several ideas in the form of incomplete models. These are suggestive of the mechanisms through which shocks and policies can affect measured TFP. This analysis-in-progress emphasizes some of the unresolved frictions relevant to the case of Latin America.

Changes in Utilization Rates

One view of the factors that drive changes in measured TFP over the business cycle relies on measurement error. According to this explanation, the *effective* amount of inputs differs from the *measured* level because of changes in the rate of utilization. This in turn can change measured productivity. To illustrate how this argument works, consider a firm that uses capital and labor to produce output. Suppose that the technology can be described by a Cobb-Douglas production function of the form

$$Y = A\left(\upsilon_K K\right)^{\alpha}\left(\upsilon_L L\right)^{1-\alpha}, \tag{2.8}$$

in which K is the stock of capital, L the stock of labor, and the coefficients υ_j capture the rate of utilization of each factor. Installed capital is difficult to reallocate. Thus, shocks that require decreased output can be accommodated by decreasing the utilization rate of capital.

A similar argument applies to labor. In a downturn, a firm may find it optimal not to lay off specialized workers—either because it expects to rehire them or because of the costs associated with layoffs. In such cases, υ_K and υ_L are less than one. Measured TFP is simply

$$TFP = A\left(\upsilon_K\right)^{\alpha}\left(\upsilon_L\right)^{1-\alpha}. \tag{2.9}$$

It follows that variations in the rate of input utilization will be indistinguishable from changes in the productivity parameter (A). Though this argument may be plausible for analysis of a business cycle (Burnside and Eichenbaum, 1996), the changes in utilization rates do not satisfactorily explain decreases in measured TFP that persist for a decade or more. In economies with adjustment costs, widespread changes in utilization rates can possibly persist. A compelling challenge for future research is to construct quantitatively realistic models that deliver these results.

Changes in Relative Prices

A change in relative prices is a second shock that could give rise to movements in measured TFP. To illustrate, consider a two-sector economy in which output of good i satisfies

$$Y_i = AK_i^{\alpha}\left(e^{h_i}L_i\right)^{1-\alpha}, \tag{2.10}$$

in which L_i is employment in sector i, and h_i is a measure of sector-specific human capital.

Consider an initial situation in which the prices of the two goods are equal, and normalize $h_2 = 0$. Since human capital is sector specific, wages (per unit of h) need not be equal across sectors. However, since capital is mobile, we impose the condition that the rate of capital return must be the same in the two sectors. A simple calculation shows that total output of this economy is given by

(2.11)

To capture the possibility that shocks might "destroy" human capital, let us assume that specific human capital will be lost if a worker from Sector One reallocates to Sector Two. Thus, the difference between e^{h_i} and 1 is a measure of industry-specific lost human capital as a result of reallocations.

I use this simple economy to study the impact upon measured TFP of a shock to the relative price of Good One received by producers. Let the postshock price of Good One (p') satisfy

$$p' = p/(1+\phi). \tag{2.12}$$

In the short run, the allocation of capital across sectors is fixed; and the total supply of hours is also constant at

$$L = L_1 + L_2. \tag{2.13}$$

Unlike capital, labor can be reallocated across sectors. Simple (but tedious) calculations show that aggregate output (at constant preshock prices) is given by

$$Y' = Y\left[\zeta\left(\frac{L_1'}{L_1}\right)^{1-\alpha}\frac{1}{1+\phi} + (1-\zeta)\left(\frac{L_2'}{L_2}\right)^{1-\alpha}\right], \tag{2.14}$$

in which ζ is the share of GDP corresponding to Sector One,

$$\zeta = \frac{e^{h_i} L_1}{L_2 + e^{h_i} L_1}. \tag{2.15}$$

From an aggregate point of view—the one taken in the computation of TFP—the stock of capital (K) and the stock of labor (L) have not changed. Thus, any change in output is interpreted as a change in TFP. In this case, *changes* in measured TFP are given by

$$\Delta TFP = \zeta\left(\frac{L_1'}{L_1}\right)^{1-\alpha}\frac{1}{1+\phi} + (1-\zeta)\left(\frac{L_2'}{L_2}\right)^{1-\alpha}. \tag{2.16}$$

If ϕ equals zero, it follows that $L_1' = L_1$ and $L_2' = L_2$; and there is no change in measured TFP. Thus, for this mechanism to affect productivity, relative producer prices must respond to a shock.

Can these relative price effects be quantitatively important? As a rough indication, consider the case in which Sector One employs 30 percent of the work force (that is, $L_1/(L_1 + L_2) = 0.3$) and the sector-specific human capital generates a wage premium of 10 percent (that is, e^{h_i} equals 1.1). For this economy, a 20 percent decrease in the relative price of Good One (that is, ϕ equals 0.2) results in a *decrease* in measured TFP of almost 30 percent. In this case, the postshock share of employment in Sector One decreases by more than 16 percent (from .30 to .25). Since some workers lose their jobs in Sector One and then find employment in Sector Two, their "effective" human capital is lost. However, since aggregate employment (and the identity of those employed) is unchanged, aggregate measures of labor (both raw and quality adjusted) are also unchanged.

One question raised by this example is whether the measured change in TFP is greater when the sector-specific human capital is more important. To study this possibility, consider a similar economy in which initial industry-specific human capital is somewhat greater—for example, e^{h_i} equals 1.15. In this case, the decrease in measured TFP is substantially smaller, less than 20 percent. Thus, contrary to intuition, immobility induced by sector-specific skills makes measured decreases in TFP *less* severe. The reason for this is that a larger change in wages is required to induce workers to give up the extra income that they receive in their original industry. Thus, for a given price shock, fewer workers reallocate, hence, the smaller the change in TFP. In an extreme case in which neither capital nor labor is mobile, there is *no* change in measured TFP. The reason is simple: if inputs are not mobile, then physical output does not change. Since the prices used to compute GDP are fixed, there is no change in measured output.

To ascertain the quantitative importance of this effect it is necessary to have access to the relevant price data. What these prices are, precisely, depends on institutional details. With *no* difference between consumer and producer prices, a decrease in TFP should be accompanied by changes in measured relative prices. In this case, the link is relatively easy to see and to quantify. However, if there are policies that create a *wedge* between cost per unit and market price, the implications are less obvious. To illustrate, suppose that the producers of Good One receive a subsidy at rate τ. In this case, the price that determines resource allocation is not p but $(1+\tau)p$. Consider the case of a "shock" that consists of an elimination of the subsidy. Let p' represent the after-shock market price (also the amount received by the firm per unit of output). The key comparison is now between p' and $(1+\tau)p$. Without further assumptions, little can be said. However, if the good in question is traded internationally—and hence, its market price is independent of demand—it follows that p' equals p; and the relative price shock is equal to the change in the tax rate. In this case, recorded relative prices do not change, and economy-wide price data are *not* useful for detecting this type of shock. Measured TFP decreases as a result of the elimination of subsidies. Of course, the mechanism is symmetric: increases in subsidies (starting from a neutral situation) also decrease measured TFP.

This mechanism appears to be a reasonable approximation of government policies (for example, industrial subsidies) that have sometimes been pursued. More precise evidence will have to be analyzed to determine whether such distortions actually constitute a significant source of changes in TFP.

Changes in Exchange Rates and the Terms of Trade

In some cases, changes in the relative price of imported inputs can induce changes in measured TFP. Consider a one-sector model in which aggregate output is produced using capital, labor (setting aside human capital for the moment), and imported intermediate inputs. The aggregate production function is

$$Q = AK^{\alpha}L^{\beta}M^{1-\alpha-\beta}, \tag{2.17}$$

in which M is a measure of intermediate inputs.

The representative firm maximizes total output minus the cost of producing it. Thus, if p_M is the price of imported inputs and e the exchange rate, it follows that value added (GDP) is

$$Y = (\alpha + \beta) A K^{\alpha} L^{\beta} M^{1-\alpha-\beta}. \tag{2.18}$$

Substituting the equilibrium demand for imports in expression (2.18), it follows that domestic output is

$$Y = (\alpha + \beta) A \left(\frac{A(1-\alpha-\beta)}{e p_M} \right)^{\frac{1-(\alpha+\beta)}{\alpha+\beta}} K^{\frac{\alpha}{\alpha+\beta}} L^{\frac{\beta}{\alpha+\beta}}. \tag{2.19}$$

In this case, measured TFP is

$$TFP = \frac{Y}{K^{\frac{\alpha}{\alpha+\beta}} L^{\frac{\beta}{\alpha+\beta}}} = (\alpha + \beta) A \left(\frac{A(1-\alpha-\beta)}{e p_M} \right)^{\frac{1-(\alpha+\beta)}{\alpha+\beta}}. \tag{2.20}$$

The previous equation shows that increases in the relative price of imports—whether from changes in the exchange rate or the terms of trade—can result in lower measured TFP.

Can this channel explain the observed changes in TFP in the context of Latin America? Clearly, Latin American economies have experienced large shocks to their real exchange rates, as well as to their terms of trade. Several country studies in this volume provide concrete evidence that the real exchange rate and the terms of trade affect measured TFP. Nevertheless, the existence of a correlation, even with the correct timing, is insufficient rationale for accepting this mechanism as the culprit behind movements in TFP.

We need to determine if the theory is consistent with the *magnitude* of the changes. To this end, note that the elasticity of TFP with respect to the price of imports is $[1-(\alpha+\beta)]/(\alpha+\beta)$, which is also the share of intermediate goods imports in domestic value added. If we consider a country whose imports are 10 percent of GDP, then extremely large increases in import prices (or real exchange rate shocks) are necessary to account for drops in measured TFP in the range of 10 to 20 percent.

Is it possible that the quantitative effect of a change in p_M is much larger than the estimate provided by the previous model because of a misspecified production function? To analyze this possibility, I consider a different specification of the technology. In particular, I assume that, once installed, capital and imported inputs are perfect complements. I also assume a per-period cost of operating capital equal to c_K. To be specific, assume that the (short-run) technology is

$$Q = AL^{1-\alpha}\left[\min\left(K, \eta M\right)\right]^{\alpha}. \tag{2.21}$$

It can be shown that, in this case, domestic value added is

$$Y = A\left(\frac{\eta c_K + (1-\alpha)ep_M}{\eta c_K + ep_M}\right)K^{\alpha}L^{1-\alpha}, \tag{2.22}$$

and measured TFP is

$$TFP = A\left(\frac{\eta c_K + (1-\alpha)ep_M}{\eta c_K + ep_M}\right). \tag{2.23}$$

As in the Cobb-Douglas case, increases in the exchange rate and the price of imported inputs tend to reduce measured TFP.

How large is this effect? It is possible to show that

$$TFP = A\frac{1}{1+\zeta}, \tag{2.24}$$

in which, as before, ζ is the ratio of the value of imports of intermediate inputs relative to GDP. Thus, the model predicts a *negative* correlation between imports and GDP. The reason is simple. An increase in import costs reduces import volume and the rate of capital utilization, and simultaneously reduces domestic value added since imports must be subtracted from total output. Even for this more rigid specification, the magnitude of observed changes in import shares is insufficient to account for the large changes in TFP. Of course, a richer model—in terms of technology specification—can generate quantitatively reasonable estimates.

It is often said that the price of capital goods is affected by changes in the exchange rate, and this in turn affects investment and output. Though this may be so, it may be more relevant, as argued previously, to explaining changes in production factors than to changes in TFP. To illustrate, consider a steady-state version of the model with a Cobb-Douglas production function. In the long run, the marginal product of capital must be equal to the rental price of capital. Let the domestic price of capital be ep_K, the interest rate be r, and the depreciation rate be δ. The equilibrium capital-labor ratio satisfies

$$(r+\delta)ep_K = \alpha A\left(\frac{A(1-\alpha-\beta)}{ep_M}\right)^{\frac{1-(\alpha+\beta)}{\alpha+\beta}}\left(\frac{K}{L}\right)^{-\frac{\beta}{\alpha+\beta}}. \qquad (2.25)$$

Increases in the exchange rate (e), the price of capital goods (p_K), and the price of intermediate imported inputs (p_M) reduce the equilibrium capital-labor ratio. However, equation (2.19) still holds, and those shocks do not affect measured GDP.

As these examples suggest, shocks to exchange rates or terms can influence measured TFP. However, there are two reasons why these shocks, by themselves, are not a promising candidate to explain changes in TFP. First, as discussed above, extremely large shocks would be required to explain substantial changes in measured productivity using standard parameter values. While exchange rate and terms-of-trade shocks could arguably contribute to some change in measured productivity, these contributions could not be large. Second, if this were the "true" source of movements in TFP, the best response would be to ignore TFP movements altogether. Why? Because these shocks only capture measurement error. They do not affect welfare in a way that standard policies could or should control. If national accounts were computed using current (instead of base-year) prices, the model would predict *no* effects on TFP.

Changes in Public Investment Policies

At one point or another, nearly every Latin American country has vigorously promoted public investment policies in the past 50 years. The investment criteria adopted by governments vary widely over time, by country, and across countries; so the efficiency of respective policies and investments is difficult to ascertain.

Within the sample in this volume, Peru stands out as an example of a country that pursued significant but particularly inefficient investments, especially between 1968 and 1990 (Chapter 7).[8] At the other end of the spectrum, Chile after 1985 appears to have applied standard efficiency criteria in shaping its public investment.

This section shows that inefficient public investment policies can account for both increases in the capital-output ratio and decreases in measured TFP. This is consistent with the evidence from Peru.

Let the technology be given by

$$Y_t = AK_t^{\alpha}\left(e^{h_t}L_t\right)^{1-\alpha}. \tag{2.26}$$

Assume that the relevant aggregate capital stock (K_t) is a combination of private and government capital. Specifically, let

$$K_t = K_{Pt}^{\eta}K_{Gt}^{1-\eta}. \tag{2.27}$$

The Cobb-Douglas specification for the composite capital stock assumes that the elasticity of substitution between private and public capital is constant and equal to one. This formulation simplifies the presentation. The main qualitative results can be obtained using more general aggregators if they display constant returns to scale.

Given an interest rate r and a unit price of capital p_k, the amounts of private and government capital solve

[8] Paraguay during the construction of the Itaipú hydroelectric project is another example of large but possibly inefficient public investment.

$$p_k(r+\delta)=(1-\tau^k)\alpha\eta\frac{Y_t}{K_{Pt}}, \tag{2.28a}$$

$$p_k(r+\delta)=(1+s)\alpha(1-\eta)\frac{Y_t}{K_{Gt}}, \tag{2.28b}$$

respectively, where δ is the depreciation factor. In expression (2.28a), τ^k measures distortions that affect private investment. It is expressed as a "tax-rate equivalent" level of distortion. Intuitively, it gives the value of a tax rate on capital income that would be required to rationalize a given investment level. I assume that $0<\tau^k<1$, and that increases in τ^k correspond to more-distorted economies. The factor $(1 + s)$ is a measure of the inefficiency of government spending. In the context of this simple economy, an efficient level of public capital is obtained when s equals zero.

Using the two previous expressions, measured TFP can be given by

$$TFP \equiv \frac{Y_t}{\bar{K}_t^{\alpha}\left(e^{h_t}L_t\right)^{1-\alpha}} = A\left(\frac{\left(\eta(1-\tau^k)\right)^{\eta}\left((1-\eta)(1+s)\right)^{1-\eta}}{\eta(1-\tau^k)+(1-\eta)(1+s)}\right)^{\alpha}, \tag{2.29}$$

in which

$$\bar{K}_t = K_{Pt} + K_{Gt}. \tag{2.29a}$$

Equation (2.29) summarizes the impact on measured TFP of both the barriers to private capital accumulation and the subsidies to public capital. It is easy to see that this expression is at its maximum when τ^k equals s, which equals zero.

Are distortions of this sort quantitatively important? To tackle that question, estimates must be obtained for the vector (η,τ^k,s) during each period. To illustrate, consider values that might be relevant for Peru, 1968–90. I assume that prior to 1968 and after 1990 the relative components of total capital were undistorted. Since the share of private capital was approximately 75 percent during those periods, I assume η equals 0.75; and that before 1968, τ^k equals *s*, which equals zero. For 1968–90, the restrictions on private capital were such that its private marginal product would have been about 80 percent of its true marginal product. This implies that τ^k equals 0.2. Finally, I select the value *s* corresponding to the 1968–90 period to match the change in capital-output ratio. According to Carranza, Fernández-Baca, and Morón (Chapter 7), the increase in the aggregate K/Y ratio is 90 percent. This implies that *s* equals 4.2.[9] With these values, the simple model predicts a decrease in TFP of approximately 12 percent. This is a substantial drop, yet it falls short of the cumulative 1.5 percent per year decrease estimated by the authors.

In summary, a simple model that relies on misallocation of public investment can explain both large increases in the capital-output ratio and significant decreases in measured TFP. In this case, the main channel through which policy affects TFP is the induced misallocation of the two forms of capital—private and public.

Changes in Sector-Specific Subsidies

In many Latin American economies, prices of specific inputs vary by sector and geographic area. The price differences are driven by a variety of policy and institutional features. For example, the firm-specific cost of a unit of labor can be affected by, among other factors, sectoral or regional promotional regimes, temporary contracts,[10] and differing enforcement of labor laws. Variations in the cost of capital can result from policies that direct credit to specific sectors and regions, or from imperfections of capital markets.

[9] This estimate implies that the actual marginal product of public capital was about 20 percent of its efficient level. This represents a high degree of inefficiency, yet it is not inconsistent with the analysis of Carranza, Fernández-Baca, and Morón in Chapter 7.

[10] Take, for example, regimes that confer tax-exempt status to some firms. This effect is particularly relevant when the incidence of social security taxes varies across firms. This can be driven by explicit differences in legal regime, or it can be the result of the interaction between regulations and technology. For example, if temporary workers are exempt from social security contributions, firms that hire easily replaceable workers effectively benefit from a lower price of labor.

Can differences in factor input prices across sectors and regions account for changes in TFP? The simple intuition is that the resulting allocation of TFP is likely to be inside the production possibilities frontier when different productive units face different prices. In this sense, changes in the distortions that affect resource allocation can also influence "the distance" of the economy from the efficient frontier and, hence, the size of measured TFP. To illustrate, consider an economy that produces a large number of perfectly substitutable goods indexed by i.[11] The production technology for sector i is

$$y_{it} = Ak_{it}^{\alpha} n_{it}^{\theta} a_i^{1-\alpha-\theta}, \qquad 0 < (\alpha, \theta) < 1, \qquad \alpha + \theta < 1, \tag{2.30}$$

where k_{it} and n_{it} are, respectively, the amount of capital and labor allocated sector i. The factor a_i, assumed to be fixed, is interpreted as managerial ability, although it is a stand-in for all sector-specific factors. It is also a measure of the size of each sector. It turns out that allowing the a_is to be jointly distributed with the distortions has no impact on the predictions of the model for the measurement of TFP. Thus, without loss of generality, set a_i equals one for all instances of i.[12]

To model distortionary policy, we assume that the government affects firms' effective factor prices through the use of sector-specific regulations and/or subsidies. More precisely, if the price of a factor is p on the "open market," a producer in sector i faces a price of $p/(1-\tau_i^j)$, where τ_i^j is the tax/subsidy rate faced by producers in sector i when purchasing input j. If τ_i^j is positive, it corresponds to a tax; if it is negative, it is a subsidy. Note that although producers face an "effective" price given by $p/(1-\tau_i^j)$, factor owners receive only p. The difference is a tax or subsidy that accrues to the residual claimants. I assume that both inputs are mobile. However, results

[11] Alternatively, it is possible to interpret i as an index of the location where the homogeneous good is produced. Both interpretations—different sectors or different regions—produce exactly the same results.

[12] The assumption is that the function is homogeneous of degree one in all factors, implying that changes in a_i correspond to changes in the size of each sector.

are identical if capital is not mobile ex post, that is, if capital is assigned to a specific sector before the sectoral realization of the tax or subsidy rates is known.

In order to characterize more precisely the role of the cross-sectional variability in incentives, we assume, first, that the joint distribution of the logarithms of $\left(1-\tau_{it}^{n},\ 1-\tau_{it}^{k}\right)$ is normal, with mean $\left(1-\mu_{n},\ 1-\mu_{k}\right)$, and variance-covariance matrix with diagonal elements σ_n^2 and σ_k^2, and off-diagonal elements given by $\rho\sigma_n\sigma_k$. Thus, ρ measures how strongly the two sectoral distortions are correlated. A positive ρ indicates that sectors with high capital taxes (or subsidies) are also sectors with high labor taxes (or subsidies).

As shown in Manuelli (2003), aggregate output is given by

$$y_t = \Delta\left(\sigma_n, \sigma_k, \rho\right) A k_t^{\alpha} n_t^{\theta}, \tag{2.31}$$

in which the function $\Delta\left(\sigma_n, \sigma_k, \rho\right)$ satisfies

$$\Delta\left(\sigma_n, \sigma_k, \rho\right) = \exp\left\{-\frac{1}{1-\alpha-\theta}\left[\frac{\theta(1-\alpha)\sigma_n^2}{2} + \frac{\alpha(1-\theta)\sigma_k^2}{2} + \rho\alpha\theta\sigma_n\sigma_k\right]\right\}. \tag{2.32}$$

In the absence of distortions, TFP in this economy is just *A*. Thus, $\Delta\left(\sigma_n, \sigma_k, \rho\right)$ is a measure of the TFP "gap." If either σ_n or σ_k are positive, then $\Delta\left(\sigma_n, \sigma_k, \rho\right) < 1$, and *actual* TFP falls short of *potential* TFP. In this setting, distortionary government policies decrease TFP. What drives the results?

- *The mean level of distortion does not affect TFP*. Since the μ_j do not enter in the expression for the TFP gap, $\Delta\left(\sigma_n, \sigma_k, \rho\right)$, changes in mean taxes (or subsidies) do not affect TFP. This is analogous to the result discussed at the beginning of this section: high average distortions have an impact on factor use but not on measured TFP.

- *The cross-sectional variation of distortions affects TFP*. Increases in the variances of the two taxes (or the correlation between the two tax instruments) result in a *decrease* in measured TFP. This approach suggests that dispersion of sectoral (or regional) incentives corresponds to low measured TFP.
- *More-distorted economies have disproportionately lower TFP*. The TFP gap is proportionally larger the greater the level of variability. This follows since the function $\Delta(\sigma_n, \sigma_k, \rho)$ is strictly convex in $(\sigma_n, \sigma_k, \rho)$. Thus, the cost of additional variability is greater the more distortionary the initial situation.

Are these effects quantitatively important? A complete answer would require empirically reasonable values for the relevant measures of dispersion. Unfortunately, no such data are available to estimate these second moments. But as a first pass, I study the quantitative effects of different levels of distortion. For substantial but not extreme variability, I find that the model predicts large drops in TFP.

Consider an economy in which the "true" shares of capital and labor are equal to 0.4, or α and θ are equal, and each equals 0.4. This implies that if a_i is interpreted as returns to managerial ability, total returns to labor and managerial ability are 60 percent of output.[13] Without a priori knowledge on whether capital or labor distortion is more severe, I assume that σ_n, σ_k and σ are equal. For the lognormal distribution, the coefficient of variation is approximately equal to the standard deviation of the variable's logarithm. Thus, the values of (σ_n, σ_k) should be interpreted as measures of the cross-sectional variability of incentives relative to the mean level of distortion. Thus, a value of 0.5 corresponds to the case in which the coefficient of variation is 50 percent. I consider values of σ in the interval [0.1,

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[13] The National Income and Product Accounts use arbitrary rules to allocate the return to some factors. In some instances, special skills—for example, owner's organizational skills—are likely to be counted as profits and therefore part of the return to capital. This would argue for smaller values of α and higher values of θ. In other cases, the same skills are priced by the market and counted as labor compensation.

0.7], with increment size equal to 0.1, and several values of the correlation coefficient ρ. The resulting measured TFP for each combination is presented in Table 2.1.

Two significant patterns stand out. First, for high but not extreme levels of variability, the model generates a substantial drop in TFP. For example, a country in which distortions are uncorrelated $(\rho = 0)$ and the standard deviation of incentives is 50 percent $(\sigma = 0.5)$ is predicted to have a level of TFP that is 25 percent lower than a country with no distortions. Second and more interesting, when distortions are correlated within a sector (that is, for high values of ρ), even moderate cross-sectional coefficients of variation can result in large losses in productivity. In the example above, the drop in TFP is nearly 40 percent if the assumption of zero correlation is replaced with perfect correlation $(\rho = 1)$. From this numerical exercise, policy distortions' correlation across sectors is clearly as important as their variability when it comes to estimating their corresponding output costs. Clearly, high-distortion countries (or periods)—measured by σ_k and σ_n—are also low-TFP countries (periods).

As a practical matter, directly measuring the "gaps" $(\tau_{it}^n, \tau_{it}^k)$ is quite difficult because a number of different distortions are simultaneously captured. However, the impact of the relevant coefficients upon some observables—that is, the second moments of the distribution of distortions—can be determined. As it turns out, the model predicts the effect of $(\sigma_n, \sigma_k, \rho)$ on the capital-labor ratio and on the return to managerial ability.

Table 2.1. TFP Gap

σ	ρ					
	–0.8	**–0.4**	**0.0**	**0.4**	**0.8**	**1.0**
0.1	0.99	0.99	0.98	0.98	0.98	0.98
0.2	0.98	0.97	0.95	0.94	0.93	0.92
0.3	0.95	0.92	0.90	0.87	0.85	0.83
0.4	0.91	0.87	0.83	0.78	0.74	0.73
0.5	0.87	0.80	0.75	0.68	0.63	0.61
0.6	0.82	0.73	0.65	0.58	0.52	0.49
0.7	0.76	0.65	0.56	0.47	0.41	0.38

Let κ_{it} be the capital-labor ratio in sector i at time t. It can be shown (Manuelli, 2003) that the variance of the cross-sectional distribution of the (log of the) capital-labor ratio is given by

$$\sigma^2(\ln \kappa_{it}) = \sigma_k^2 + \sigma_n^2 - 2\rho\sigma_k\sigma_n. \tag{2.33}$$

In the absence of cross-sectional variability in tax or subsidies, $\sigma^2(\ln \kappa_{it})$ should therefore be zero. Evidence of variability—especially changes over time—indirectly suggests the presence of distortions.

Another variable that depends on $(\sigma_n, \sigma_k, \rho)$ is the unit price of the sector-specific resource (a_i). In applications, this is a measure of ex post profits beyond the normal rate of return to capital or excess payments to managers. The unit price of a_i, denoted p_i, is given by

$$p_i = (1-\alpha-\theta)\frac{y_i}{a_i}. \tag{2.34}$$

It follows that the variance of $\ln p_{it}$ is given by

$$\sigma^2(\ln p_{it}) = \left(\frac{\alpha}{1-\alpha-\theta}\right)^2 \sigma_k^2 + \left(\frac{\theta}{1-\alpha-\theta}\right)^2 \sigma_n^2 - \frac{2\alpha\theta}{(1-\alpha-\theta)^2}\rho\sigma_k\sigma_n. \tag{2.35}$$

As is the case regarding the capital-labor ratio, variability in pure profit across sectors indirectly suggests the presence of the kinds of distortions that are discussed above.

In weighing the relevance of this model, a final consideration is that a real shock asymmetrically affects all sectors. If economic authorities respond to a shock by providing positive incentives to help those most affected, cross-sectional variance in *effective* incentives may arise. In the context of this model, TFP would be further reduced. This is suggestive rather than definitive; the exact quantitative importance of this channel calls out to be fully studied and understood. The challenge will be, first, to identify changes in (σ_n, σ_k), and in that light, to then quantitatively determine the implications for both factor accumulation and measured productivity.

Labor Market Distortions I: Formal and Informal Sectors

By international standards, Latin American labor market institutions strongly protect formal employment. At the same time, the rate of compliance with labor codes in Latin America is relatively low (Inter-American Development Bank, 2003). Although noncompliance is difficult to measure, both direct anecdotal and indirect evidence suggest that noncompliant firms are generally less productive.[14] In this subsection, I explore how changes in the regulation of labor markets affect measured productivity. For this analysis, I set aside the impact of policy on individual productivity. My present approach emphasizes the consequences of shocks on the allocation of labor between the high-productivity (formal) and the low-productivity (informal) sectors. To this end, a theory must be sufficiently rich to accommodate the observation that in equilibrium some workers voluntarily choose to be employed in the low-productivity sector despite higher wages in the formal sector. I use a version of a matching model (Mortensen and Pissarides, 1994) adapted to capture the differences between formal and informal sectors.

In explaining the coexistence of both sectors in equilibrium, I assume that jobs in the formal sector are difficult to find—in other words, that workers generally stay in the informal sector only until they find jobs in the formal sector. Thus, employment in the low-productivity (informal) sector and the search for high-wage jobs are complementary.[15]

Let us assume that labor productivity in the formal sector (y) exceeds its counterpart in the informal sector (z). I ignore capital in order to simplify the presentation, even though the level of productivity in the formal sector can be viewed as a function of capital per worker. Let u be the number of workers in the informal sector who are looking for formal sec-

[14] For example, using the fraction of employment that is not covered by social security regulations as an indicator of informality, it follows that workers with little or no education, young workers, and workers employed in small firms are more likely to be in the informal sector (see IDB, 2003).
[15] This is an extreme simplification. A more realistic model would allow for unemployment and variable search efforts. However, the less complex model sketched out here is adequate for describing the main qualitative results.

tor jobs, and let v be the number of vacancies available in the formal sector. Following the matching literature (Mortensen and Pissarides, 1994; Diamond, 1992), the number of successful matches increasingly becomes a function of both u and v. It is given by $AM(u,v)$. In light of findings by Blanchard and Diamond (1990), I assume that returns to scale in matching are constant; hence, M is homogeneous of degree one. This implies that only the ratio of vacancies to employment in the informal sector, denoted θ, matters in determining the allocation of workers to the two sectors.

Let $\theta q(\theta)$ be the job-finding rate. Then

$$\theta q(\theta) \equiv \frac{AM(u,v)}{u} = AM(1,\theta). \tag{2.36}$$

The function $\theta q(\theta)$ is increasing in θ. This is intuitive. It says simply that an increase in the number of vacancies per worker looking for formal-sector jobs results in a high job-finding rate. Note that a change in A corresponds to a change in the efficiency of the matching process.

I assume that jobs in the formal sector are exogenously destroyed at the rate s. Informal-sector jobs can be obtained instantaneously, so the rate at which they are destroyed is basically irrelevant. Formal-sector firms must pay corporate income tax and the employer share of social security tax. Moreover, they face costs in creating vacancies (c) and in terminating employment (F).[16] Workers in the formal sector pay both income and social security taxes on their income from the formal sector. Both firms and workers in the informal sector evade taxation. To simplify the presentation, I assume that employment in the informal sector requires no matching.[17] Firms maximize expected profits and workers maximize the expected discounted value of income (I ignore risk aversion).

[16] These costs correspond to lost resources. They do not include firms' transfers to workers for government-mandated or union-negotiated severance payments. They include the administrative expenses that a firm incurs in order to fire a worker, such as lawyer fees and the costs of negotiating with labor unions.
[17] This is equivalent to an infinite job-finding rate.

Given an equilibrium job-finding rate $\theta q(\theta)$, the number of workers in the informal sector at time $t + 1$ satisfies

$$u_{t+1} = (1 - u_t)s + (1 - \theta_t q(\theta_t))u_t. \tag{2.37}$$

The first term on the right-hand side of the equation, $(1 - u_t)$, is the fraction of workers in the formal sector who lose their jobs at time t. The second term is the fraction of workers in the informal sector who do *not* find formal-sector jobs at time t. For any initial condition u_0, and given a guess as to the evolution of θ_t, equation (2.37) can be used to determine employment in the informal sector.

Aggregate labor productivity—which corresponds to TFP in this economy with fixed capital—is given by

$$a_t = y(1 - u_t) + zu_t. \tag{2.38}$$

In this simple model, factors increasing the share of workers in the informal sector lead to lower measured (and actual) TFP. To highlight the role played by distortions and shocks, I concentrate on the steady state. In the steady state, average labor productivity is

$$a = \frac{y\theta q(\theta) + zs}{\theta q(\theta) + s}, \tag{2.39}$$

and wages in the formal sector are given by

$$w = \frac{z + \phi\left[\left(1 - \tau^{\pi}\right)y - z + \theta c + F\left(1 - \beta + \beta s \theta q(\theta)\right)\right]}{(1 - \tau)(1 - \phi) + \phi\left(1 - \tau^{\pi}\right)\left(1 + \tau^{s}\right)}, \tag{2.40}$$

where τ^{π} is the corporate tax rate; τ^{s} is the employer's share of the social security tax; τ is the tax rate for workers in the formal sector, which combines income and social security taxes; and ϕ is a measure of the worker's bargaining strength (for details, see Manuelli, 2004).

In equilibrium, θ is a function of all the parameters of this economy. As shown in Manuelli (2004), it is the solution to

$$\frac{z+\phi\left[\left(1-\tau^{\pi}\right)y-z+\theta c+F\left(1-\beta+\beta s\theta q(\theta)\right)\right]}{\left(1-\tau\right)\left(1-\phi\right)+\phi\left(1-\tau^{\pi}\right)\left(1+\tau^{s}\right)} = y-\frac{1}{\left(1-\tau^{\pi}\right)\left(1+\tau^{s}\right)}\left[\frac{\left(r+s\right)c}{q(\theta)}+\beta sF\right]. \tag{2.41}$$

Equation (2.41) summarizes the implications of the model for the ratio of formal-sector vacancies to informal-sector employment (θ). Given this quantity, equation (2.39) can be used to evaluate the impact on TFP. Before proceeding, it is useful to characterize the exogenous variables of the model in terms of the kinds of shocks and distortions that are captured.

Movements in the vector $\left(\tau^{\pi},\tau^{s},\tau\right)$ capture not only variation in tax rates but changes in the "wedges" between prices and marginal products. Shocks to the productivity parameters (y, z) can be interpreted in several ways. First, they obviously capture actual real shocks. Second, they also represent variations in labor regulations and enforcement of labor laws—for example, a mandated increase in holiday time. Given that y is a (flow) measure of productivity per period, the increase in holiday time results in fewer effective hours worked and a decrease in y. Similarly, a relaxation in the enforcement of labor regulations (and tax collection) can result in more-efficient technologies being used in the informal sector, which could be captured as an increase in z. Shifts in labor regulations can affect the efficiency of the matching between workers and firms. These appear as shifts in the function $q(\theta)$. On the other hand, policy changes that increase the degree of protection of formal jobs are captured by movements in F. Macroeconomic shocks that affect job instability correspond to movements in the rate of job destruction (s). Regulations that hinder firms' creation of jobs in the formal sector are captured in increases in c, the cost of opening a vacancy. Thus, this simple setting is sufficiently rich to derive implications for both measured TFP and wages in the formal sector.

The main *qualitative* results are the following:

- *Productivity shocks*. An increase in y unambiguously increases measured TFP. The impact of an increase in z is ambiguous. The direct effect is to increase TFP; however, since this induces more workers to accept jobs in the informal sector, this second effect tends to decrease productivity. An increase in job instability (s) decreases the share of workers in the formal sector and, consequently, will result in lower productivity.
- *Policy shocks*. Even though I formally model policy shocks as tax-rate shocks, they actually capture all forms of "wedges" between marginal products and market prices. Increases in τ^{π} and τ^{s} induce more workers to find jobs in the informal sector. Measured productivity (and wages in the formal sector) decrease. An increase in τ also results in lower measured TFP. However, in this case, wages rise in the formal sector.
- *Distortions*. In the context of this simple model, a downward shift in the matching function captures increased rigidities in the labor market. A decrease in $q(\theta)$ results in lower measured TFP (because more individuals work in the informal sector) and lower wages in the formal sector. An increase in the cost of creating a job vacancy (c) also induces a reallocation of employment from the formal to the informal sector and the consequent decrease in measured TFP. The impact on wages is ambiguous. On the one hand, firms are willing to pay less given the higher costs of job creation. On the other hand, the "size" of the surplus from a match increases, making workers with jobs in the formal sector more demanding.
- *Labor market regulations*. As discussed above, changes in required benefits can be modeled as a decrease in y; and at the same time, they appear as a decrease in labor input (if properly measured). If these are the only effects, then measured TFP does not change. However, in this model the decrease in y results in a decrease in the wage rate in the formal sector (w), which in turns induces a

> reallocation of workers toward lower-productivity jobs in the informal sector. This results in lower TFP. An increase in the cost of firing (*F*) decreases the share of employment in the formal sector. Its impact on wages is ambiguous.

Are the predictions consistent with the evidence? Without adequate employment data for the respective sectors, it is not possible to directly test the model. However, indirect evidence suggests that the forces that we identified have some predictive power in explaining movements in TFP. If the formal sector corresponds to jobs with social security benefits and if the informal sector corresponds to jobs without such benefits, the flow of workers between sectors is significant in some Latin American countries. In Argentina, approximately 10 percent of workers in formal-sector jobs transitioned to informal-sector jobs in a six-month period. At the other end, approximately 12 percent of informal-sector workers found formal-sector jobs during the same period. This corresponds to estimates of s of 0.10 and $\theta q(\theta)$ of 0.12. Ignoring unemployment, this implies that about 45 percent of all jobs are in the informal sector. The actual value for Argentina is somewhere between 40 percent (salaried workers only) and 55 percent (all who are employed). Since the class of employed individuals must surely include some part-time family members, the model's estimate of 45 percent appears to approximate the actual value.

Using a measure of "conditions of employment" that includes each country's laws and regulations on maximum workweek hours, overtime, night shifts, holidays, workday hours, vacation days, and maternity and other leaves, a study of the Inter-American Development Bank (2003, Appendix Table 7.1) found that increases in an index of such legislated benefits corresponded to a rising fraction of self-employed workers, who are also likely to be low productivity in the model. However, the same variable does not seem to affect the growth rate of TFP. Social security contributions have negative effects on both the employment rate and the rate of employment growth.

The evidence on the impact of job security is mixed. Heckman and Pagés (2003) review the evidence for Latin America and note that in some countries (for example, Argentina and Peru), greater job security lowers employment rates in manufacturing (a sector with a relatively larger share of formal firms). Studies of labor reforms in Chile and Brazil find no evidence of significant effects.

Even though it is difficult to have accurate measures of c, the indicators for start-up costs, compiled by the World Economic Forum (2003), show that the cost of creating a firm in the median Latin American country is higher than in the median country of any other region in the world. Using the index as a cardinal measure, the firm creation cost for Latin America is more than double that of the median developed country. On these grounds, Latin American TFP should be lower, on average, than that in developed countries. Unfortunately, we lack confirmatory time-series evidence on the behavior of these barriers to firm creation.

Overall, these ideas seem promising and worth pursuing. They suggest that changes in TFP are associated with changes in the sectoral allocation of labor. Assuming that informality is higher in the service sector (excluding government services), the model is consistent with evidence from Hopenhayn and Neumeyer that decreases in changes in TFP co-move with employment in the service sector (Chapter 3).

Labor Market Distortions II: Search Costs

It is widely believed that Latin American labor markets are less transparent than labor markets in developed countries. In particular, the ability of workers to move from job to job is probably low relative to other regions. Is it possible that changes in the cost of job searching will appear as changes in TFP? For insight into this question, I consider a model in which formal-sector wages are drawn from a given distribution G. As in the previous model, the informal sector offers a wage equal to z, normalized to 0. Unlike in the previous model, however, workers in the formal sector can search while employed. The cost of searching is κ. Assume, as before, that the exogenous rate of job destruction is s. In this setting, it can be shown that workers with wages greater than a given cutoff $\left(w^*\right)$ do not search, where w^* is given by

$$\kappa(1-\beta s)=\frac{\beta(1-s)}{1-\beta(1-s)}\int_{w^*}^{\infty}(w-w^*)G(dw). \tag{2.42}$$

It follows that if both the cost of searching and the rate of job destruction increase, the cutoff wage $(\overline{w})$ decreases while job turnover increases. Differences in the amount of job turnover result in differences in average productivity. When many workers are searching, a smaller fraction is employed in low-wage jobs at any point. Thus, the average wage—equal to productivity in this model—increases with mobility. To formalize this intuition, let $N_t(w)$ represent the fraction of employed workers in jobs paying w at most. If so, a simple argument shows that this cumulative distribution function satisfies the following difference equation:

$$N_{t+1}(w)=\begin{cases} N_t(w)(1-s)G(w)+sG(w), & w\le w^* \\ \left(N_t(w)-N_t(w^*)\right)(1-s)+(1-s)N_t(w^*)G(w)+sG(w), & w\ge w^* \end{cases}. \tag{2.43}$$

The steady-state wage distribution is

$$N(w)=\begin{cases} \dfrac{sG(w)}{1-(1-s)G(w)}, & w\le w^* \\ \dfrac{G(w)-(1-s)G(w^*)}{1-(1-s)G(w^*)}, & w\ge w^* \end{cases}. \tag{2.44}$$

Standard arguments show that steady-state average wages (and average productivity) are

$$\overline{w}=\int wN(dw)=\int(1-N(w)dw). \tag{2.45}$$

It follows that increases in the search cost decrease average wages (or average productivity). The formal expression is given as

$$\frac{\partial \overline{w}}{\partial \kappa} = \int_{w^*}^{\infty} \frac{1-G(w)}{\left(1-(1-s)G(w^*)\right)^2}(1-s)g(w^*)\frac{\partial w^*}{\partial \kappa}dw < 0. \qquad (2.46)$$

Thus, the average productivity of two countries with identical distribution of entry-level jobs (and identical distribution of accepted wages) can differ because of differences in search costs. Since employment and capital are the same in these two economies, the effects of search costs are captured in measured TFP.

Uncertainty and Investment

Latin American economic policies are typically characterized by instability. Major policy reversals within a very few years have been commonplace in countries such as Peru, Argentina, and Brazil. In this section, I present several examples suggesting that lower investment and output are consequences of policy-driven swings in demand faced by firms, and shifts in policy-sensitive factors such as interest rates. I also show that the delays expected when a regime change occurs also have a detrimental impact on investment.

Following McDonald and Siegel (1986), I consider the optimal timing for a firm to make an irreversible investment (for example, building a plant) when facing stochastically fluctuating demand. Let profits (π_t) satisfy

$$d\pi_t = \mu\pi_t + \sigma\pi_t dW_t, \qquad (2.47)$$

where W_t is a standard Brownian motion. This specification implies that the mean growth rate of profits is μ, and the instantaneous standard deviation is $\sigma\pi_t$. Let the cost of the investment be *I*, and the interest rate (assumed to be constant for the time being) be *r*. The firm's problem is to find a time (that is, a stopping time) to maximize

$$V(\pi;\sigma,r,\mu) = \sup_{\tau} E\left[e^{-rt}(X_\tau - 1) \middle| \pi_0 = \pi\right].$$

It can be shown that the optimal investment rule is: build the plant as soon as profits reach level π^*, as given by

$$\pi^* = \frac{\theta}{\theta - 1}(r - \mu)I, \tag{2.48}$$

where $\theta > 1$ is a function of both the mean growth rate (μ) and its standard deviation σ. Increases in μ and σ decrease θ, while increases in r (the interest rate) have the opposite effect. Thus, increases in demand uncertainty generate delay. Before making the investment decision, the firm would wait until potential profits are higher relative to an identical firm in a more stable environment. From the perspective of the impact on output, what's relevant is not "investment threshold" but the impact on the average time until the investment is made. A simple calculation shows that, given that potential profits today are at the level π, the expected delay is

$$\bar{\tau}(\pi; \sigma, r, \mu) = \frac{1}{\mu - \sigma^2/2} \ln\left(\frac{\pi^*}{\pi}\right). \tag{2.49}$$

It follows that

- Increases in demand uncertainty result in a postponement of investment.
- Increases in the interest rate delay investment.

In many Latin American countries, government policies have an impact on the variability of factor prices. This is particularly important in the case of interest rates. During periods of major reform when countries are faced with large external shocks, interest rates tend to be highly variable. The effects of variable interest rates can be modeled in several ways. I consider two possibilities here. First, I study how shocks affect the "speed of adjustment" to long-term interest rates. This exercise aims at capturing the effects of transitory versus permanent shocks. I then extend the model to allow for permanently fluctuating interest rates.

Consider the case in which profits grow at a deterministic rate. More precisely, potential profits evolve according to equation (2.47), with σ equal to zero. Thus, at time t profits are $\pi_t = \pi e^{\mu t}$, where π is the initial level of profits. Assume that the interest rate is locked in when the project is implemented. Thus, the net present discounted value of the investment project that is implemented at time t is $\pi_t/(r_t - \mu) - I$. To capture changes, the interest rate is assumed to evolve according to

$$dr_t = \phi r_t \left(1 - \frac{r_t}{\bar{r}}\right) dt. \tag{2.50}$$

Thus, the long-term interest rate is $\bar{r}$. This setting will be used to study how differences in ϕ affect investment. Higher values of ϕ are interpreted as capturing a faster adjustment process or more-credible reforms. Greater uncertainty over the impact of a policy (or an external shock) can manifest in slower speeds of adjustment. This also captures increases in the permanence of government policies that prevent adjustment. The model will then capture the slower adjustment speed through increases in ϕ. It is possible to show that the length of time to implement a project (T)—given initial interest rate r, an initial level of potential profits π, and a speed-of-adjustment parameter ϕ—is the solution to

$$\pi e^{\mu T} = \bar{r} I + (r - \bar{r}) \left\{ \frac{I}{e^{\phi T} r + (r - \bar{r})} + \frac{\phi}{e^{\phi T}\left[r(\bar{r} - \mu) + \mu(r - \bar{r})e^{-\phi T}\right]^2} \right\}. \tag{2.51}$$

To understand the effects of policy shocks on decisions to delay investment, consider the following simple scenario: suppose that a country's (current) budget policy is not feasible over the long run, and it is known that a future adjustment will eventually result in a decrease in the interest rate. Assume the best policy to be instantaneous adjustment and that the current interest rate exceeds the long-run rate, $r > \bar{r}$. If the instantaneous adjustment scenario also results in an instantaneous convergence of the interest rate to its long-term value (formally, I take the limit in (2.51) to be when ϕ approaches infinity), the previous expression shows that the equilibrium level of delay is given by

$$\pi e^{\mu T_0} = \bar{r} I. \tag{2.52}$$

This result is intuitive. It says that the investment should be made at the point when profit flow equals the capital cost of investment using the long-term interest rate. Now consider the effect of a policy shock that announces a *delay* in the adjustment. Even in the unlikely event that the delay affects neither the short- nor the long-term interest rate, it will result in a lower value of ϕ. Then equation (2.51) shows that the optimal timing of investment is when T_1 exceeds T_0, and the required threshold of profitability to build a plant increases. In the aggregate, investment decreases. Thus, as expected, policies that result in slower convergence of interest rates—for example, policies that delay necessary adjustment or those viewed as simply unfeasible—result in lower levels of investment.

In the previous example, interest rate variability is only temporary since every path converges to the deterministic value of the long-term interest rate $\bar{r}$. However, investment delays can also be caused by permanent uncertainty over the cost of capital. To capture this possibility, assume that the interest rate evolves according to

$$dr_t = \phi r_t \left(1 - \frac{r_t}{\bar{r}}\right) dt + \gamma r_t dW_t, \tag{2.53}$$

where W_t is a standard Brownian motion, and γ is a measure of interest rate volatility. Under standard conditions, the long-term interest rate (Alvarez and Shepp, 1998) is given by

$$\lim_{t \to \infty} E[r_t] = \bar{r}\left(1 - \frac{\gamma^2}{2\phi}\right), \tag{2.54}$$

which falls below the nonstochastic long-term interest rate $\bar{r}$. On the demand side, I simplify the model and assume that the present value of the implemented investment project is independent of the interest rate, and evolves according to $v_t = ve^{\mu t}$.[18] The firm's problem is to choose the optimal timing of investment, τ, to maximize the expected present discounted value of profits, given by

$$V(v,r;\gamma) = \sup_{\tau} E\left[e^{-\int_0^{\tau} r_s ds}(v_t - I)dt \middle| v_0 = v, r_0 = r \right]. \quad (2.55)$$

Under standard regularity conditions, it can be shown that increases in the variability of interest rates (γ) result in the firm choosing higher cutoff rates for the minimum acceptable v_t and, consequently, lower investment.

To summarize, policy shocks that increase the level of uncertainty over demand or the cost of capital result in firms requiring higher levels of profitability before they will invest in a new plant or equipment. In the aggregate, these policy shocks tend to reduce investment. Policy changes that delay (necessary) adjustment have similar effects.

Even though these shocks cannot directly explain decreases in measured TFP, they are consistent with anecdotal evidence that movements in productivity and the age of the capital stock are negatively correlated. Thus, uncertainty that delays investment increases the average age of the capital stock, and appears as a slowdown in the growth rate of TFP since newer capital goods are more productive.

Country Studies

This section sums up some key results from the individual country studies in this volume.

[18] This, of course, is an extreme assumption. Allowing interest rates to influence present project value complicates the analysis.

Argentina (Chapter 3)

In their analysis of Argentina's "Great Depression" of 1975–90, Hopenhayn and Neumeyer argue that Argentina's growth during the past 50 years can reasonably be broken into three distinct periods. The first, 1950–74, was characterized by relatively low but stable growth in per capita income. The second period, 1975–90, witnessed a substantial decrease in per capita income. Per capita output decreased at a cumulative rate of more than 1 percent a year. The third period, the 1990s, saw sustained growth. Per capita income rose more than 4 percent during the 1991–97 subperiod.

Policy shocks, the authors argue, are at least partially responsible for Argentina's disappointing performance during the 15 years between 1975 and 1990. They explore how a rapid succession of policy changes and persistent uncertainty over expected reversals contributed to the economy's poor aggregate performance—and also help explain some otherwise puzzling observations.

According to the authors, the main features of the Argentine economy are as follows:

Behavior of Quantities

- During 1950–74, the economy appears to have been on a balanced growth path. Output per worker grew at an annual rate of just under 1.8 percent. Growth was partially fueled by the increasing capital-output ratio, which rose at 1.49 percent annually. Labor reallocation in the sectoral composition of employment was very limited.
- The period 1975–90 witnessed an annual decline in per capita income of about 1 percent a year. The stock of capital per worker declined by 0.70 percent, and measured TFP dropped 1.67 percent. However, the capital-deepening process did not completely stop. To the contrary, the capital-output ratio increased on average 0.49 percent per year, and the stock of human capital per worker grew almost 1.5 percent per year. The structure of

production and employment shifted significantly. Employment in services as a share of total employment increased substantially at the expense of employment in agriculture and manufacturing.

- The 1990s witnessed an increase in per capita income, as well as high growth rates in both capital per worker and measured productivity. Increased TFP was mainly responsible for driving the growth process. The capital-output ratio *decreased* at a rate greater than 2.2 percent per year, with the stock of human capital per worker growing at a much slower rate.

Behavior of Prices

- The real exchange rate appreciated temporarily during the late 1970s. During the 1980s, the level was roughly comparable to that of the pre-1975 period. In real terms, the peso did not appreciate significantly during the 1990s. Episodes of frequent policy reversals and high inflation were strongly characterized by high volatility in the real exchange rate.
- Even though trade policy was revised substantially during the period under study, the authors found that the level of protection during the 1990s was surprisingly similar to that in other decades. The internal terms of trade (that is, the domestic price of imports relative to exports) increased significantly in relation to the external terms of trade (that is, the international price of imports relative to exports) in 1975 and throughout the 1980s. This relative price, moreover, was characterized by substantial variability. The relative price of capital goods peaked in 1975 and 1983; however, the longer-term trend was overall decline.
- Until 1977, domestic interest rates stayed well below the market clearing price, and credit was rationed. During the 1980s, however, interest rates exceeded 20 percent annually in real terms, decreasing in the 1990s to about 10 percent.

Hopenhayn and Neumeyer employ several models that, in principle, can be used to shed light on the kinds of policies and shocks that so strongly influenced Argentina's economic performance.

First, they consider a model in which capital is fixed and the degree of substitutability of capital and labor is much lower in manufacturing than in services. In this setting, increases in the labor force led to lower relative prices and higher employment in the service sector, as was actually the case in Argentina.

At constant prices this reallocation is consistent with the drop in measured TFP. A key element of the argument is that the stock of capital is held (approximately) constant. Why is this? Hopenhayn and Neumeyer point out that the increase in real interest rates and in the price of investment goods in the 1980s reduces the demand for capital. Thus, they attribute the poor performance of the economy to bad policies.

The model corresponds well with several observations for Argentina, yet it cannot account for the substantial drop in output that occurred after 1975. To develop a more inclusive explanation, Hopenhayn and Neumeyer studied how policy uncertainty affects the desired capital stock. They considered the impact of pursuing an infeasible trade policy. Because the policy is widely believed to be unworkable, economic agents expect it to change in the future. However, they are uncertain about the *timing* of the reform. This uncertainty effectively increases the investment cost because firms must consider the option value of waiting in order to avoid a capital loss from investing in the "wrong" sector. The authors show that policy uncertainty can reduce output and induce a substantial employment reallocation.

The expanded model works fairly well to explain Argentina's Great Depression of the 1980s. However, further work remains to be done, since this setup cannot rationalize the decrease in measured TFP during the prereform period or the subsequent increase in the 1990s.

Brazil (Chapter 4)

Castelar Pinheiro, Gill, Servén and Thomas traced the determinants of growth in both factors and TFP over the entire course of the 20th century. In addition to aggregate analysis, they also investigate the determinants of TFP and income growth at the micro level.

Brazil experienced steady increases in output per worker from 1900 to 1980, exceeding 3 percent in nearly every subperiod. As in the rest of Latin America, the 1980s were a decade of negative growth. Output per worker decreased at 0.5 percent per year in the 1980–93 period. After 1994, Brazil resumed its earlier long-term growth rate, and output per worker increased at a rate of 3.4 percent in the 1994–2000 period.

What are the sources of Brazil's growth?

- *Capital.* Before 1993, the capital-output ratio substantially increased, with the highest growth rate—1.8 percent per year—during the 1951–63 period. As in Argentina, the negative per capita growth of 1981–93 did not come about as a result of capital shallowing. To the contrary, the capital-output ratio grew nearly 1 percent a year. Nevertheless, among the individual components contributing to growth, significant divergent behavior is hidden behind these aggregate figures. It is particularly noteworthy that the stock of machinery and equipment decreased at a rate of over 2.5 percent per year. Thus, the increase in aggregate capital was mostly driven by the construction sector. The post-1993 recovery of output was not driven by investment. More specifically, the capital-output ratio decreased at an annual rate of 0.65 percent. However, as a mirror image of the previous period, investment in machinery and equipment increased at an annual rate that exceeded 7 percent per year.
- *Labor*. The stock of human capital per worker, as measured by years of schooling, expanded significantly prior to 1980. The average rate of increase exceeded 2 percent. After 1980, however, the growth rate of human capital per worker slowed substantially to 0.5 percent. As with capital, the recovery that started in 1994 was not driven by improved quality of the workforce.
- *Total Factor Productivity*. With the exception of 1981–93, TFP in Brazil grew at an annual rate of over 2 percent. During 1981–93,

the rate was negative, though much smaller (0.66 percent per year) than that of other Latin American countries.

With the exception of the 1980–93 period, the relatively stable aggregate performance of the Brazilian economy disguises significant changes in the composition of output. In 1900, the agricultural sector accounted for 45 percent of GDP, but by 2000, it accounted for less than 13 percent. By contrast, the industrial sector's share increased from 13.2 percent in 1900 to 38.4 percent in 2000.

During this period, economic policy in Brazil underwent significant change. Given the findings of Castelar Pinheiro et al., it appears that the policy changes substantially affected the composition of output and had much smaller aggregate effects. To determine which factors best explain Brazil's relative growth within the region, the authors used a sample of Latin American countries to estimate a growth regression. Their explanatory variables can be grouped into three categories:

- *Shocks*. A measure of world growth is included to account for aggregate shocks and to partially control for external demand shocks. In addition, a measure of Brazil's terms of trade is included.
- *Policies*. The rate of inflation and the black-market premium are included. Although these variables can directly affect growth, it is more likely that they capture infeasible budget and exchange regime policies—and that these variables are not independent of each other. They also consider a measure of openness, given by the ratio of the sum of imports and exports relative to GDP.
- *Factors*. To control for changes in factors in their explanatory variables, the authors include the investment rate, years of secondary schooling, and life expectancy. To allow for convergence effects, they also include initial income per capita.

The regression is estimated using data for 20 Latin American countries covering the period 1960–99. Results of the regression generally confirm findings of De Gregorio and Lee reported in Appendix A. The exception is openness, which is not found to be significant. In contrast to De Gregorio and Lee and Blyde and Fernández-Arias (Chapter 1), Castelar Pinheiro et al. do not include institutional variables. Their regression results predict Brazil's growth rate for each period of the 20th century *relative* to 1964–80, and they compute the contribution of each variable to the prediction. Several findings are noteworthy:

- The growth regression performs reasonably well in the sense that prediction errors are small (except for 1994–2000, in which growth is severely overpredicted).
- For 1931–50, the low growth rate of world GDP, relatively low life-expectancy, and insufficient investment are the main factors accounting for the lower per capita GDP growth rate relative to the –2.65 percent observed in 1964–80.
- The 1951–63 period presents a small deficit relative to the reference period. The most important determinants are life expectancy and schooling. Other variables have relatively small aggregate impact.
- The slow growth period of 1981–93 is partially explained by high inflation and slow growth in world output.
- It is noteworthy that the period 1994–2000 appears to be quite unlike other periods. The regression result predicts a positive growth differential of 1.45 percent, but the data show a large negative differential of –4.74 percent. What explains this optimistic (but unfortunately wrong) forecast? The most important factors are improvements in measures of human capital—life expectancy and schooling. But as offsetting factors, world growth and low investment predictably drove the differential growth rate downward.

In the Brazilian case, policies that affect human capital formation have substantially affected growth. Yet despite their importance, the level of these variables alone does not accurately predict growth. Rather, it suggests that the sectoral allocation of resources is basically another channel through which human capital and growth are linked. Among policy variables, Brazil's high inflation during the 1980s stands out in terms of negative impact. In addition, policies that discouraged investment also reduced growth.

As argued above, TFP growth appears to have been a key to Brazil's recent performance. To better understand the determinants of productivity growth, the authors study a sample of industries that cover the 1987–98 period, and analyzed factors affecting TFP at the firm level. Several findings are of interest. First, it appears that productivity moves less at the firm than at the aggregate level. These data lend support to the view that measured changes in TFP are only partially influenced by variations in the technology level—because measurement errors, as discussed in the previous section, are less likely to be important with firm-level data. Second, measures that capture exposure to international competition are associated with higher TFP—in particular, lower tariffs, a more depreciated real exchange rate, and a larger share of imports. Third, policies that affect the age distribution of firms—for example, barriers to firm creation and aid packages for older firms—matter for TFP since older firms display both low levels of productivity and low growth rates. Finally, several measures that capture the quality of the capital stock and the skill level of the labor force are far less significant than expected. Overall, these regression results provide low explanatory power. So what explains large movements in measured productivity? This analysis points to policies that create misallocation of resources at the macro level. It does not seem that those policies influence TFP at the firm level.

How do different macro policies affect welfare? The authors studied income growth at the household and state level for 1980–2000. Their major finding is that improvements in schooling have contributed to both increasing growth and reducing inequality. Other factors that influence income growth—in particular, among the poor—include low inflation and access to higher-quality infrastructure. Overall, the authors argue that the road to higher growth in Brazil is continuing policy emphasis on human capital formation, low barriers to international trade, and fiscal policy consistent with low inflation.

Chile (Chapter 5)

Chumacero and Fuentes studied Chilean economic growth for the four decades since 1960. They distinguish two main subperiods. The first, 1960–74, witnessed a GDP per worker growth rate of slightly more than 2 percent. Chilean economic policy mostly followed the recommendations of the ECLAC during this interval, emphasizing protection of domestically produced goods. The subperiod culminated with substantial intervention in the economy during the Allende administration in the early 1970s. The second subperiod, 1974–2000, was characterized by higher average growth and more variability in the growth rate of GDP per worker. During this interval, Chilean economic policy was characterized by trade liberalization, decreased regulation of the domestic private sector, and privatization of many government-controlled economic activities.

Unlike in other Latin American economies, TFP's growth contribution in Chile was not large over the entire period. However, this generalization obscures significantly different behavior during periods of fast versus slow growth. Between 1960 and 2000, the growth rate of GDP per worker was 2.15 percent. Of this, approximately 11 percent can be accounted for by increases in TFP, with the remaining 89 percent corresponding to variation in inputs. However, during three subperiods of relatively fast growth, the contribution of TFP was significantly higher—18 percent for 1960–71, 88 percent for 1975–81, and 48 percent for 1985–98.

These observations suggest that during periods of stable economic policy, such as 1960–71, TFP does not move much. However, during reform periods, such as 1975–81 and 1985–98, changes in TFP account for a large share of growth.

Chumacero and Fuentes' analysis of the factors affecting TFP suggest that TFP increases whenever

- The relative price of capital goods decreases
- The terms of trade improve
- Government's share of spending in output decreases

Chumacero and Fuentes estimate a reduced form equation in which GDP (in logs) depends on lagged GDP, a time trend, and the three shocks identified above. In addition, they estimate univariate representations for the price of capital goods, the terms of trade, and the ratio of government spending to GDP as a measure of internal distortion. They interpret these as exogenous variables that drive shocks (in addition to exogenous productivity shocks) in a standard, representative agent, stochastic growth model. In order to introduce a role for terms of trade, the authors study a two-sector model. One sector produces an exportable not consumed locally; the other produces an internationally tradable good that is also domestically consumed. They assume that trade is balanced in every period; hence, the domestic interest rate is independent of external conditions.

Chumacero and Fuentes' model is calibrated to coincide with long-term observations for Chile. It is evaluated according to its ability to replicate the impulse response functions observed in the data. From this perspective, the exercise is extremely successful. For all four shocks predicted by the model, the impulse response functions are indistinguishable from those estimated in the data.

Chumacero and Fuentes employ a neoclassical growth model in which the sole distortions are domestic taxes. As such, the model cannot capture the impact upon measured TFP of nontechnological shocks such as the price of capital, terms of trade, and government intervention. Nevertheless, their analysis proves that the factors being considered are sufficiently successful in accounting for the change in input use so as to explain aggregate growth in Chile.

Chumacero and Fuentes' work suggests important areas for future research. In particular, both their empirical work and their model point to the need to identify other shocks and domestic distortions to account for the observed correlations in TFP among the price of capital, the terms of trade, and governmental size. As the authors make clear, changes in the price of capital could well be driven by changes in the trade regime. As such, these difficult-to-quantify changes could, in a model with distortions, affect measured TFP. Another revealing finding is that periods of high output also correspond to periods of high TFP growth, as well as to periods in which major changes in domestic economic policy took place. In particular, periods of rapid growth coincide with periods in which state control of the economy was liberalized. The challenge for future research is to determine whether structural policy changes of this sort can account for the observed shifts in measured productivity and then to identify the mechanisms and channels that mediate this effect.

Paraguay (Chapter 6)

Economic growth in Paraguay for 1960–2000 was characterized by high instability. Although Paraguay's average growth rate for the entire period exceeded that of neighboring countries and Latin America as a whole, performance and behavior varied sharply within the 40 years. Relative to the average Latin American country, Paraguay underperformed in every decade except the 1970s. This decade coincides with an exogenous demand shock mostly financed by the influx of foreign capital to build the Itaipú hydroelectric complex.

In Chapter 6, Fernández Valdovinos and Monge Naranjo describe salient features of the time series corresponding to inputs and TFP. Their main results are summarized as follows:

- During the 40-year period, the stock of capital increased; moreover, its composition changed significantly. While overall capital stock rose by a factor of 13 between 1962 and 2000, output increased by a factor of less than six. Thus, the capital-output ratio increased by a factor of approximately 2.5. As the authors point out, the composition of total capital has changed greatly. The construction capital-output ratio increased by a factor of three. The equipment capital-output ratio increased 50 percent—more modest but still significant. The differences between the two ratios widened in the late 1970s, the late 1980s, and the 1990s, doubtlessly related to the massive ongoing investment in Itaipú. Fernández Valdovinos and Monge Naranjo suggest that the widening in the 1990s corresponded to a follow-up construction boom in the real estate sector.

- The labor-output ratio increased as well, approximately 50 percent over the 40 years. According to the authors, the increase in the human-capital quality of the labor force has been small.
- The stock of productive land increased in the late 1970s.
- Remarkably, TFP—which was estimated in several ways—shows a downward trend over the entire period. Depending on the methodology, small differences appear across the subperiods. Despite these differences, all estimates nonetheless point to a steady decline during the 1970s that continued until the mid-1980s. Assuming a Cobb-Douglas production function and a share of capital equal to one-third (a more standard approach), the decline in TFP continued into the 1990s. The authors also estimate a more flexible specification—in which the elasticity of substitution between capital and labor is not forced to be 1, turning out to be approximately 1.25—and they allow for nonneutral, capital-augmenting technological change. Using this alternative specification, they find that TFP grew during the second half of the 1980s but dropped in the 1990s.

According to these authors, Paraguay's development failure is driven mostly by negative growth in TFP. Surprisingly, factor accumulation remained strong in the face of declining productivity. To illustrate, they computed the hypothetical growth rate that Paraguay *would have* experienced had TFP remained unchanged, and factor accumulation continued at historical values. In this scenario, the annual per capita growth rate would have increased from 1.8 to 2.4 percent.[19] This is a significant increase. Had it happened, Paraguay would have surpassed the world average.

[19] Since the authors present multiple estimates of TFP, their results vary with the particular measure adopted. The calculation presented in the text uses the Cobb-Douglas specification with total capital. However, since all five specifications produce decreases in TFP in the range of –50 percent to –65 percent, the results do not vary much when other estimates are used.

The Paraguayan experience raises two puzzling questions. First, why did TFP decrease over such a long period? Second, what explains the accumulation of factors in the face of declining productivity? The authors do not directly study the determinants of TFP. However, they present a detailed description of real and policy shocks that Paraguay experienced during this period. Since the discussion requires a single measure of TFP, I selected the estimate presented from their CES production function. The stylized behavior using this measure shows that TFP grew 30 percent from the beginning of the period until 1973 but decreased to only 65 percent of the 1962 value by 1984. It increased to slightly more than 80 percent of its 1962 value in 1990, and then decreased to about half its 1962 level in the 1990s. In other words, there are only two periods of growth—1962–73 and 1984–90—with all other periods showing declines. No years are stable.

Despite the difficulty of singling out one factor for each subperiod, it appears that Paraguay's relatively strong performance in the 1960s was associated with an expanding agricultural frontier that facilitated dramatic change in the composition of national exports. The second period of growth coincided with reforms of the late 1980s and a positive shock in the agricultural sector. What features are primarily associated with the declines? The most significant decrease took place at the time of construction of the massive hydroelectric complex at Itaipú.[20] We can speculate that a heavy hand by government in regulating the project led to inefficiencies in resource allocation. This would also help explain the increase in factor accumulation since distorted incentives can compensate for declining productivity.

The significant drop in TFP in the 1990s is more difficult to explain. This was a period in which Paraguay liberalized its economy. However, two factors deserve particular consideration. First, when Paraguay's long-reigning dictator, Alfredo Stroessner, was ousted in 1989, uncertainty rose over future rules of the game. Economic agents may well have chosen to allocate their investment in projects that appeared safe even if more in-

[20] According to the authors, total project investment was approximately four times Paraguay's GDP.

efficient. Second, a banking crisis occurred in the mid-1990s that, according to Fernández Valdovinos and Monge Naranjo, stemmed from mistakes in the way the banking sector was liberalized. Basically, there were too few bankers who understood lending in a market environment, and deficiencies in macro policies encouraged lending for speculative activities.

Fernández Valdovinos and Monge Naranjo explore the extent to which economic integration influenced growth performance. At both high and low frequencies, they found that Paraguayan output was not highly correlated with that of its neighbors. Thus, shocks to its neighbors would be an unlikely culprit for explaining the poor underlying performance of Paraguay's economy.

In a nutshell, Paraguay experienced a sustained and large drop in measured TFP. Although evidence suggests that policy and real shocks could have influenced productivity, more work is needed to better estimate and analyze the factors that affect TFP.

Peru (Chapter 7)

Carranza, Fernández-Baca, and Morón take on two tasks in their chapter on the Peruvian economy. First, they document the country's pattern of growth. Second, they try to account for Peru's less-than-stellar economic performance during the past 25 years.

According to the authors, the 20th century can be divided into four periods of economic growth. The first lasted through the end of World War II and was characterized by moderate growth. During the second period, from 1945 to 1965, the economy grew at a higher rate. After 1965, the beginning of the third period, economic policy underwent major shifts every few years, creating great uncertainty. Although the growth rate was positive from 1965 to 1976, the next 15 years witnessed significant decline. In real terms, by 1990 GDP had dropped back to the level of the mid-1960s. Peru managed to resume positive growth in the 1990s.

Because of the limited availability of data for the first half of the century, the authors were only able to analyze sources of economic growth since 1950. Their major findings for the last five decades are as follows:

- During the first two decades, 1950 to 1970, output per worker grew at a high annual rate of over 3 percent. Since the capital-output ratio remained approximately constant, changes in human capital per worker and in TFP are the logical candidates as potential sources of growth. For the first of these two decades, no data are available on human capital. However, for the 1960s, human capital per worker (measured as average years of schooling) grew at an annual rate of over 2 percent. TFP growth was close to 2 percent a year.
- During the third and fourth decades, 1970 to 1990, output per worker decreased. In the 1970s, the growth rate was slightly positive at about 0.5 percent a year; but in the 1980s, total output declined 0.68 percent annually. This translated to negative growth in GDP per worker of –3.75 percent. In both decades, the capital-output ratio rose significantly—1.8 percent in the 1970s and 3.07 percent in the 1980s. Thus, Peru's recession was accompanied by capital deepening. Since increases in the stock of human capital also contribute to growth, it follows that TFP must have decreased. The authors provide several estimates of the change in TFP, but representative growth rate values are –0.7 percent in 1971–80 and –0.8 percent in 1981–90.
- In the fifth decade, the 1990s, the growth rate of output per worker was 1.27 percent. The capital-output ratio decreased at an annual rate of 0.75 percent, driven mostly by a reduction in the stock of machinery and equipment. The change in human capital per worker was positive, but less than previous decades. Finally, TFP grew at a rate of 2.5 percent a year.

What are the main factors influencing movements of TFP in Peru? The authors estimated a regression using the TFP level as its dependent variable and including several variables to capture the relationships between productivity and macroeconomic factors, external conditions, and changes in institutional factors. The major findings are as follows:

- High inflation, high real exchange rates, and high public debt are key macroeconomic factors associated with low TFP. Results corresponding to an openness variable are inconsistent across specifications. When it is significant, however, this variable has the expected sign; so increases in openness are associated with increases in measured TFP.
- External shocks in the form of better terms of trade and lower global interest rates are related to higher levels of TFP. According to the authors, they are not related to aggregate shocks such as measures of global or regional growth.
- Measures of structural reform were available for only part of the period under study; however, they did not appear significant.

To account for the importance of these factors in the movements of TFP, the authors decomposed the total estimated effect into its components for 1970 through 2000. The two major negative forces were changes in real exchange rates and in the level of public external debt. Both measures can serve as indicators of policy-induced distortions. In the 1980s, their effects were particularly large and negative. Global real interest rates also appeared as a negative factor in the 1980s and 1990s (though previously, they were not). Inflation increased its negative (albeit small) contribution until 1990, but then improved. At the opposite end, Peru experienced favorable terms of trade that are typically associated with higher levels of TFP. Consequently, it appears that bad internal policies, even in the face of relatively benign external conditions, are responsible for the decline in measured TFP.

How did policy affect factor accumulation? As happened in other Latin American countries, the stock of human capital per worker rose steadily in Peru, not slowing down even in the low- and negative-growth periods of the 1970s and 1980s. Yet in the 1990s, when Peru's economic policies paradoxically appeared more consistent with longer-term growth, the stock of human capital per worker declined. Why? At the aggregate level, the effects of public policy on this measure of human capital (that is, schooling) cannot be determined. This is because the index is a measure of the quality of the stock of human capital embodied in the population. Individual decisions to acquire *less* schooling in the 1980s (in other words, to invest less in human capital) would have resulted in less future aggregate human capital. Without enrollment data, however, one cannot establish simple connections between contemporaneous policies and human capital.

The behavior of the capital-output ratio is interesting. The 1970s and 1980s were periods in which the government not only seriously interfered with market signals, but also adopted highly unstable policies. Major changes often took place every four to five years. This is reflected partially in the variability of per capita GDP, which, according to Carranza, Fernández-Baca, and Morón, increased significantly in the 1980s.

As argued earlier, increased instability can generally be expected to decrease investment. Yet the increase in the capital-output ratio in Peru during this period seems to contradict expectation. The apparent paradox can be resolved by inspecting the behavior of private and public investment. Except for the four years associated with a brief liberalization in the early 1980s, private investment as a fraction of GDP decreased significantly from 1966 to 1990, after which there was substantial increase. Public investment was fairly high during the 1970s and 1980s. If public investment is not determined according to market rules, as the authors suggest, the result can manifest itself as an increase in the capital-output ratio and a decrease in measured TFP.

In summary, the authors show persuasively that policy actions were important determinants of Peru's 50-year growth experience. In particular, they find that poor macroeconomic policies—including public investment, fiscal, and monetary policies—were largely responsible for the country's poor economic performance over the past 30 years.

Uruguay (Chapter 8)

Uruguay's growth experience during the past 50 years can be divided into three intervals—a slow growth period from 1957 to 1973, a recovery during 1974–90, and an era of relatively faster growth during the 1990s. The main features of each of these periods are summarized below:

- *From 1957 to 1973.* Output grew at an average rate of 0.7 percent per year. Factor accumulation (capital and labor, and to a lesser extent, human capital) are the engines of growth. Measured TFP growth is –1.07 percent a year.
- *From 1974 to 1990.* GDP increased at an annual rate of 2.1 percent. Accumulation of capital and increases in quality-adjusted employment made equal contributions to aggregate growth. During this period, measured TFP grew at a modest 0.3 percent.
- *From 1991 to 1999.* Growth was quite fast. Total output increased at an annual rate above 3 percent, with significant growth in the stock of human capital per worker being the most important factor. Measured TFP decreased at an annual rate of 1.86 percent.

How did policies affect performance of the economy? Julio de Brun identifies two major policy changes. In 1973, the Uruguayan government initiated a process of trade liberalization that lowered the price of imported goods. Since a substantial fraction of capital goods were imported, this policy change could be expected to increase the demand for capital and the capital-output ratio (at constant prices). The second major policy change occurred in the 1990s when Uruguay joined Mercosur, the southern cone free trade association, and concurrently instituted a series of market-oriented reforms. This change could potentially account for the increase in the domestic price of skilled labor since, relative to other Mercosur countries, Uruguay had abundant high-skill labor. This contributed to the rise in supply of human capital observed in the 1990s.

To understand the impact of trade reforms, de Brun employed a complex dynamic equilibrium model that assumes an economy that produces three goods—exportables, importables, and nontraded goods. Individuals must decide how much human capital to acquire. Physical capital is produced using traded goods, while the production of human capital uses both traded and nontraded goods. To capture Uruguay's comparative advantage, exportables are assumed to be produced with capital and skilled labor; imports are assumed to be produced with capital and unskilled labor; and nontraded goods are produced with skilled labor.

De Brun uses the model to evaluate the effects of an improvement in the domestic terms of trade, which can be driven by international price changes or by changes in the trade regime. There are several relevant findings. As in the standard Stolper-Samuelson result, the relative price of skilled labor increases. This induces a process of human capital accumulation, resulting in a higher level of long-term income. Under some reasonable conditions, de Brun shows that the rate of increase in skilled workers in the sector producing exportables was higher than the increase in the nontraded sector. Nevertheless, output of nontradables and exportables went up, while domestic production of import-competing goods declined. Depending on parameters, it can be shown that total output goes up and the "engine of growth" is the accumulation of human capital.

Findings from the theoretical model appear to be consistent with the Uruguayan experience. The post–trade liberalization period—starting in 1973, with an extra shock in the early 1990s—is associated with higher growth; and more importantly, it is a period of rapid accumulation of human capital.

To test the capacity of the model to quantitatively explain Uruguay's economic performance, de Brun estimated a set of equations consistent with the theoretical construct. One equation corresponds to the production function; the other two represent the equilibrium laws of motion of physical and human capital. The empirical results conform to the theory. In particular, an index of commercial policy has a positive impact on human capital formation. In summary, the major changes in the growth experience of Uruguay seem to be reasonably well explained by the dynamic model that de Brun analyzes.

The results also pose challenges. It is somewhat puzzling, for example, that the behavior of several important variables differs among Uruguay and nearby countries given the high level of integration of their economies—in particular, Argentina and Brazil. De Brun shows that the evolution of TFP during the recovery of the 1990s was quite different in Uruguay than in Argentina and Brazil. The latter experienced a TFP-led growth during the 1990s that resulted in significant increases in capital per worker. Human capital played a minor role. By contrast, Uruguay's experience is almost the direct opposite. During the 1990s, increases in human capital fueled growth, while TFP fell and capital accumulation was not significant. More research is needed. Yet it seems evident that the different policies adopted by Uruguayan authorities, compared to the choices made by neighbors, can account for significant differences in the performance of the Southern Cone countries in recent years.

Concluding Comments

Unquestionably the economic performance of Latin American countries has been, with few exceptions, very disappointing. The set of countries represented in this volume is no exception. What causes Latin America's relative backwardness? The research papers reviewed in this chapter offer no definitive answers, but they suggest several promising avenues of inquiry. First, it is clear that, notwithstanding authors' efforts, the quality of the data is poor. This is particularly true of labor input. In most cases, it has been very difficult to measure accurately the stock of human capital over a long period of time. This is, in any case, a difficult task, but efforts to improve the measurement of aggregate quantities for the Latin American economies will generate a large payoff.

Second, the empirical findings suggest that large changes in measured TFP can account for a substantial fraction of the changes in growth rates, and that TFP movements are statistically associated with real and policy shocks. In this chapter, I presented several simple models that can "rationalize" the observed relationship. However, much more work is needed. The full implications of the models—with particular emphasis on their cross-equation restrictions—have to be fleshed out. The next step is to take the models to data by picking the deep parameters and confronting the predictions of the theoretical models with the evidence. This will be a difficult but rewarding task. The research reported in this book is an excellent first step.

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Part II

Country Studies

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CHAPTER 3

Explaining Argentina's Great Depression of 1975–90

Hugo A. Hopenhayn and Pablo A. Neumeyer[1]

In 1975 the Argentine economy entered a deep depression that lasted for 15 years. This followed 25 years of balanced growth in which per capita income expanded annually by 1.77 percent, with a stable sectoral distribution of employment. By 1990, per capita income was 23 percent below its 1975 value, and output was 40 percent below its 1935–75 trend line. Compared to the rest of Latin America and the United States, income per capita fell by 50 percent. The employment structure also changed considerably. Net job creation was concentrated entirely in the service sector, which increased its share of the labor force by 20 percent, at the expense of tradable goods employment. In the 1990s growth was restored.

Due to its magnitude and persistence, the economic contraction experienced by Argentina through the 1980s qualifies as one of the great depressions of the twentieth century (Kehoe and Prescott, 2002). Kydland and Zarazaga (2002) attempt to explain what happened through the lens of a neoclassical growth model, estimating Solow residuals from the Argentine data and feeding the estimated series as the exogenous total factor productivity (TFP) in the model. The exercise performs fairly well in explaining

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the behavior of aggregate variables during the 1980s. Yet by using exogenous TFP to explain everything, the model sheds little light on the internal factors behind Argentina's dismal economic performance.

This chapter revisits the evidence on growth in Argentina, looking at aggregate data as well as national income data by sector. At the aggregate level our analysis expands Kydland and Zarazaga's growth accounting exercise, incorporating a new series for human capital constructed from household survey data. Qualitatively, results do not change much, as we also find that most of the fall in output in 1974–90 is accounted for by a decline in the Solow residual. The decline in capital per worker accounts for only 25 percent of the fall in output.

Sectoral data for 1974–90 show the greatest change occurring in the composition of employment. Employment in the service sector increased from 57 percent of the labor force in 1970 to 77 percent in 1993, while manufacturing employment fell from 25.4 percent to 16.7 percent, and agricultural employment fell from 17.5 percent to 6.7 percent, respectively. Although resource reallocation toward the service sector (wholesale and retail trade and personal, community, and social services) also occurred in many developed economies, Argentina's shift was quite different. While reallocation was associated with a rising relative price of services in the developed countries, in Argentina the price was falling. Moreover, service sector output per worker fell as employment rose. Employment reallocation in Argentina accounts for 44 percent of the decline in per capita output between 1973 and 1993, as a shift-share decomposition of employment and output growth will show later in this chapter.

Our primary hypothesis is that government policies during 1975–90 increased capital costs, reducing the capital per worker and thereby inducing a labor reallocation. Our analysis assumes that the elasticity of substitution between capital and labor is higher in the service industry, so that new entrants to the labor force were allocated to the service sector where it was easier to substitute labor for capital.

Several factors contributed to the increase in capital costs during this period. Following a default on international debt, the 1980s were plagued by high interest rates. Indeed, during 1983–90, the average interest rate on

Argentine government debt was 22 percent, more than twice the rate for 1991–97.[2] Tariffs and other trade barriers also played a role. Argentina's trade policy between 1950 and 2000 was very volatile and relied on several instruments, including tariffs, quotas, export taxes, credit subsidies, etc. An index of trade policy distortions—that is, a summary statistic for trade policy and data on the composition of imports and exports—is used to create a proxy for the role of tariffs and quotas on the relative price of capital.[3]

In addition to the direct distortionary effect of tariffs, we argue that uncertainty about future protection was detrimental to investment. A model is presented to illustrate this in which uncertainty about future protection drives up the cost of capital in a multisector economy with irreversible investment. The two sectors in the model are a sector in which capital/labor substitution is low (tradable goods) and another in which it is high (nontraded goods). An increase in the cost of capital that reduces investment also induces labor to flow from the tradable goods sector (with low capital/labor substitution) to the nontraded sector (with high capital/labor substitution). The reallocation of labor induced by the fall in the capital stock reduces income per worker, labor productivity, and wages, as observed in the data.

Aggregate Growth Accounting

This section features a standard Solow decomposition of the growth of output per worker in Argentina. Its main contribution to previous work is the introduction of a new series for human capital.

As is standard, we assume a constant-returns-to-scale production function of the following form:

$$\frac{Y}{L} = A\left(\frac{K}{L}\right)^{\alpha} h^{1-\alpha}, \tag{3.1}$$

[2] The high rates also may be linked to the period's macro instability and massive fiscal deficits.

[3] Díaz Alejandro (1970) calculated a similar index of trade policy and argued that the distortional effect of protection on investment contributed to the slow relative growth of Argentina after the 1930s.

where Y denotes output, K is the capital stock, L is the number of workers, h is the average level of human capital, and $0 < \alpha < 1$. The growth rate of output per worker then is

$$\hat{y} = \hat{A} + \alpha\hat{k} + (1-\alpha)\hat{h}, \tag{3.2}$$

where $\hat{x}$ denotes the percentage change in x, and y and k are per worker variables.

The series for the average level of human capital is new and was computed with Argentina's permanent household survey, using the methodology described in the Appendix to this chapter. The remaining data for the growth accounting exercise come from Kydland and Zarazaga (2002), who provide their own time series for Argentine capital stock and derive data on the number of employed workers from Elías (1992) and Meloni (2000). The growth rates of output and capital per worker, our measure of h, and the growth rate of L for the three periods identified in the introduction are depicted in Table 3.1. Data on the growth of h in the full period 1949–70 are unavailable, although in 1970–74, h grew at an average rate of 2.91 percent annually.

The table shows that in the quarter century between 1949 and 1974, income per worker in Argentina grew at a rate of 1.77 percent annually, while there was substantial capital deepening. In the 15 years following 1975, output and capital per worker fell significantly before recovering in the 1990s.

Table 3.2 shows the results of a growth accounting exercise using the data from Table 3.1 and a labor share of 0.6 from Maia and Nicholson (2000).

Table 3.1. Annual Growth of Output, Capital Per Worker, Human Capital, and the Workforce
(in percent)

	Y/L	*K/L*	*h*	*L*
1949–74	1.77	3.26	n.a.*	1.69
1975–90	–1.09	–0.7	1.43	1.15
1991–97	4.35	2.12	0.63	1.85

* Results for the partial period 1970–74 show a rate of 2.91 percent.

Table 3.2. Aggregate Growth Accounting

	Contribution *K/L*	Contribution *h*	TFP
	Average annual % growth rates (% of growth of *y*)		
1949–74	1.30 (74)	—	—
1975–90	–0.28 (26)	0.86 (–79)	–1.67 (153)
1991–97	0.85 (19)	0.38 (9)	3.13 (72)

Note: Labor share = 60% (Maia and Nicholson, 2000).

The growth accounting exercise indicates that the contribution of capital to the growth of output per worker accounts for nearly three-quarters of growth in 1949–74, with the remaining 26 percent attributable to the Solow residual (without human capital). Assuming that the growth rate of *h* for 1970–74 reported earlier is a good description of the accumulation of human capital since 1949, the estimate of the growth rate of TFP for the entire period is –1.29 percent yearly. In 1975–90, output per worker fell at an average of 1.09 percent yearly for 15 years. Capital stock depletion accounts for 26 percent of the decline. After controlling for growth of the average level of human capital, aggregate TFP during this period fell at an annual average of 1.67 percent, accounting in excess for the fall in output per worker. Ignoring the growth of *h*, the Solow residual grew at a rate of –0.81 percent between 1975 and 1990. In the 1990s growth was restored, with 19 percent of growth accounted for by the contribution of capital, 9 percent by the contribution of human capital, and the remaining 72 percent by the Solow residual.

Labor Reallocation and Output Per Worker

The extent of sectoral reallocation of labor was substantial. Table 3.3 indicates the progressive transition of employment from primary (agriculture and mining) and secondary (manufacturing) sectors to services. The largest increases in services occurred in the 1970s and 1980s. According to Table 3.5 these changes were concentrated in trade (wholesale and retail), and community, social, and personal services. These sectors account for most

Table 3.3. Sectoral Structure of Employment
(in percent)

	Agr. and mining	Manufacturing	Services
1950	19.9	27.9	52.1
1960	18.2	26.7	55.1
1970	17.5	25.4	57.1
1980	12.7	20.0	67.4
1987	11.4	18.2	70.5
1993	6.7	16.7	76.6
1997	7.5	15.1	77.4

of the increase in services (20.4 percentage points). All of this increase occurred in the 1970s and 1980s.

Figure 3.1 depicts the evolution of employment in agriculture and mining; manufacturing; personal, community, and social services; and other services. It shows that behind the changes in employment shown in the previous table there is steady employment in the tradable-goods sector and growth of employment in services: all net entry to the labor force was absorbed by the service sector.

Figure 3.1. Employment by Sector

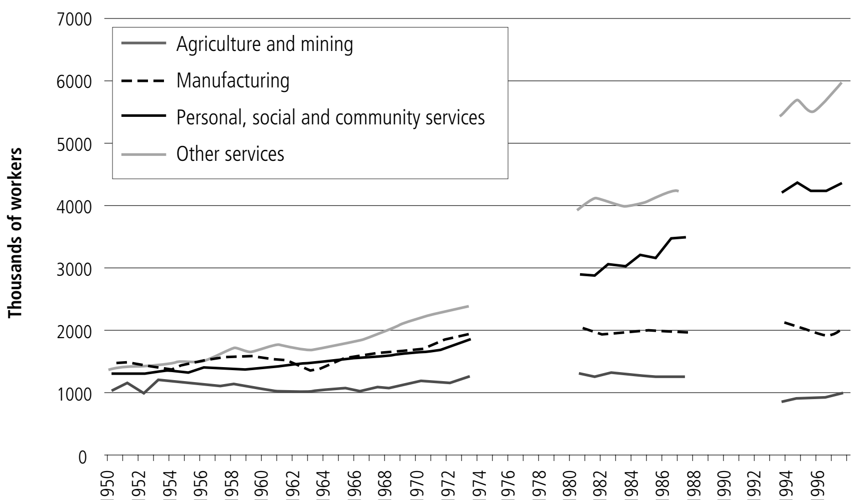


Table 3.4. Reallocation Index

1950–60	1960–70	1970–80	1980–87	1987–93	1993–97
0.035	0.04	0.135	0.07	0.065	0.025

To measure the extent of sectoral reallocation, the following index was constructed:

$$R_{t,t+1} = \frac{1}{2}\sum_i \left| l_{it} - l_{it+1} \right|, \tag{3.3}$$

where l_{it} is the share of total employment of sector i in period t. The reallocation index takes values between zero and one, where the extremes correspond, respectively, to no reallocation and to the case in which all employment moves to a non-preexisting sector. Table 3.4 shows that the greatest reallocation occurred in the 1970s and 1980s, when growth rates were lowest.

We explore the relationship between the observed changes in the allocation of labor and output per worker through a shift-share analysis. Output per worker can be written as the sum of output per worker in each sector of the economy times the share of employment in that sector, that is,

$$y_t = \sum_i l_{it} y_{it}, \tag{3.4}$$

where the subindex i represents each of the goods or groups of goods produced in the economy,

$$l_{it} = L_{it}/L_t, y_{it} = p_{i0} Y_{it}/L_{it}, \tag{3.5}$$

and p_{i0} represents the prices of a base year. The shift-share decomposition of this expression links the annual average growth rate of output per worker between t and $t + n$ to changes in output per worker and in employment shares as shown in (3.6):

$$\frac{1}{n}\ln\frac{y_{t+n}}{y_t}=\frac{1}{n}\ln\frac{\sum_i l_{it}y_{it+n}}{\sum_i l_{it}y_{it}}+\frac{1}{n}\ln\frac{\sum_i l_{it+n}y_{it}}{\sum_i l_{it}y_{it}}+\frac{1}{n}\ln\frac{\dfrac{\sum_i l_{it+n}y_{it+n}}{\sum_i l_{it+n}y_{it}}}{\dfrac{\sum_i l_{it}y_{it+n}}{\sum_i l_{it}y_{it}}}. \quad (3.6)$$

The first term on the right-hand side measures the within change, or shift component, which is a weighted average of the increase in TFP, capital per worker, and average human capital in each sector as shown by

$$\frac{\sum_i l_{it}y_{it+n}}{\sum_i l_{it}y_{it}}=\sum_i\frac{p_{it}Y_{it}}{Y_t}\left(1+\hat{A}_i+\alpha_i\hat{k}_i+\left(1-\alpha_i\right)\hat{h}_i\right). \quad (3.7)$$

If there is balanced growth, the within component should account for 100 percent of the change in output per worker. The second term in (3.6) corresponds to the between change, or share component, and it captures how much of the growth in y is due to pure reallocations of labor across sectors, with constant output per worker in each sector. If labor flows from sectors with low output per worker to sectors with high output per worker, this term is positive, and vice versa. The third term in (3.6) is an interaction effect, which is negative if there is a transfer of labor to sectors with relatively low rates of output growth per worker. The interaction can be important and negative if labor flows from sectors in which output per worker rises to sectors in which it falls. This was the dominant effect in Argentina in the late 1970s and in the 1980s.

Table 3.5 contains the raw data used in the shift-share analysis, showing the interaction between changes in the employment structure and changes in output per worker. Between 1970 and 1993, the employment share of agriculture fell by 11 percent of the labor force, while productivity showed significant gains. Manufacturing employment fell by 8 percent of the labor force, while the sector's productivity remained roughly constant. The largest gains in employment shares occurred in wholesale and retail trade and in personal, community, and social services, sectors in which output per worker experienced significant drops. Observe that output per worker in the trade sector was higher than in agriculture and manufacturing in 1970,

Table 3.5. Labor Allocations and Output Per Worker: Argentina (1950–97)

	Agriculture		Mining		Manufacturing		Electricity, gas, water		Construction	
Years	Labor share (%)	Output per worker	Labor share (%)	Output per worker	Labor share (%)	Output per worker	Labor share (%)	Output per worker	Labor share (%)	Output per worker
1950	19	93	1	97	28	100	1	93	6	77
1960	17	115	1	190	27	140	1	124	7	70
1970	17	112	1	347	25	213	1	305	10	79
1970	17	119	1	443	25	169	1	308	10	95
1980	12	137	1	537	20	163	1	455	11	91
1980	12	74	1	490	20	181	1	189	11	98
1987	11	82	0	543	18	179	1	220	7	115
1993	6	137	0	980	17	183	1	344	7	93
1993	6	95	0	585	17	130	1	323	7	92
1997	7	89	0	807	15	153	1	476	8	96

	Wholesale and retail trade, restaurants, and hotels		Transport, storage and communications		Banking, insurance and real estate		Community, social and personal services		Output per worker
Years	Labor share (%)	Output per worker	Labor share (%)	Output per worker	Labor share (%)	Output per worker	Labor share (%)	Output per worker	
1950	10	186	8	110	1	289	25	63	100
1960	12	192	8	113	2	263	25	74	121
1970	11	247	8	142	2	241	24	85	154
1970	11	209	8	216	2	520	24	91	154
1980	17	104	5	267	4	253	29	65	129
1980	17	133	5	99	4	405	29	77	129
1987	20	97	5	108	5	353	32	70	120
1993	22	87	6	104	7	262	33	64	119
1993	22	88	6	141	7	320	33	69	119
1997	24	93	6	170	7	372	33	72	131

and that this was not so in 1980. It is also worth noting that the personal, social, and community service sector grew considerably despite being the least productive in the economy. This sector includes government employment. Although the financial sector is small in terms of employment, it is important because of its dramatic declines in productivity.

Table 3.6 shows the shift-share decomposition of productivity growth described in (3.6). The qualitative changes in output per worker mimic the pattern of changes in total factor productivity given earlier in the chapter, with positive growth until 1973 followed by negative growth in the late 1970s and in the 1980s before returning to positive growth in the 1990s.

The remarkable thing about the 1950–70 period is that most of the change in output per worker is explained by the within component. Argentina during this period seems to have followed a balanced growth path. Deepening capital and rising productivity account for most of the economic growth.

For 20 years post-1973, the growth of output per worker was negative. Reallocation was a major factor, explaining 44 percent of the fall in output per worker in the 1973–80 and 1980–93 subsamples. The combined effects of reallocation induced an average annual decrease in output per worker of 2.5 percent in 1973–80, while in 1980–93 output per worker fell an average of –0.59 percent annually, of which –0.26 percent (or 44 percent of the total change) was due to reallocation. Forty-four percent of the change in output for 1973–93 can be explained by reallocation effects, significantly more than the 25 percent attributed to capital in the aggregate growth accounting exercise.

Most of the within decrease in output per worker in the late 1970s and the 1980s is explained by a two-thirds fall in productivity in the retail

Table 3.6. Shift-Share Analysis

	Output per worker	Within change	Between change	Interaction
1950–70	2.14	2.11 (93)	0.08 (4)	–0.05 (–2)
1973–80	–2.50	–1.40 (56)	0.36 (–15)	–1.46 (59)
1980–93	–0.59	–0.33 (56)	0.32 (–54)	–0.06 (97)
1993–97	2.44	1.07 (44)	–1.84 (–75)	3.21 (131)

Note: Figures represent average annual rates of growth in %; figures in parentheses represent % of total change.

trade sector and a one-third fall in productivity of community, social, and personal services. These two sectors increased their share of employment from 11 percent and 24 percent of the labor force in 1970 to 20 percent and 32 percent in 1987, respectively. The large negative value of the interaction term captures the fact that the service sector absorbed a large fraction of the labor force while experiencing a declining output per worker.

In the 1990s growth and investment rebound, but the reallocation effects are still important. The overall reallocation effect induced an increase in aggregate output per worker of 1.37 percent yearly, which accounts for 56 percent of the total change. The within change was 1.07 percent yearly and accounts for the remaining 44 percent of total change.

To put the shift-share analysis for Argentina in perspective, Table 3.7 presents data for Chile, Mexico, Canada, Finland, Italy, Norway, and the United States. The sample contains all OECD and Latin American countries for which data could be obtained. The results are interesting, especially for the OECD countries, because these nations also experienced significant changes in the composition of their labor forces, with about 20 percent of the workforce moving to the service sector. The table, however, shows that the Argentine case is quite different.

The table reveals that the only cases in which the reallocation component of the shift-share analysis is important are Chile in the period 1980–86 and the United States in the period 1975–80. The Chilean case resembles Argentina's since it encompassed a deep recession in which output and capital per worker were falling. The reallocation effect accounts for 42 percent of the 1 percent yearly decline in output per worker. In the case of the United States, output per worker grew at an annual rate of 0.19 percent, the within change was negative (productivity slowdown), and the reallocation effect was 0.45 percent annually. Thus the reallocation effect in the late 1970s was positive.

Another key difference separates the reallocation of labor in Argentina from that of developed countries. In Argentina the relative price of services fell while employment in the sector was growing; in the developed countries the price increased.

Table 3.7. Shift-Share Analysis for Seven Countries
(in percent)

	Output per worker	Within change	Output per worker	Within change
	Chile		**Canada**	
1970–75	–1.34	–1.34 (100)	0.92	0.56 (61)
1975–80	3.38	3.63 (107)	0.60	0.42 (71)
1980–86	–0.99	–0.57 (58)	1.42	1.43 (101)
1986–90	2.27	1.57 (69)	0.21	0.10 (49)
1990–95	4.85	4.45 (92)	1.34	1.41 (105)
	Finland		**Italy**	
1970–75	3.64	2.38 (66)	2.53	1.43 (57)
1975–80	2.66	2.13 (80)	2.82	1.89 (67)
1980–85	2.51	2.12 (84)	1.49	0.16 (11)
1985–90	3.10	2.62 (85)	1.97	1.16 (59)
1990–95	3.33	3.33 (100)	1.84	1.55 (85)
	Mexico		**Norway**	
1970–75	2.60	2.34 (90)	3.16	2.16 (69)
1975–80	1.24	1.47 (118)	2.06	1.71 (83)
1980–85	0.37	0.17 (47)	2.23	1.69 (76)
1985–90	0.18	0.16 (88)	1.87	2.16 (115)
1990–95	—	—	2.72	2.80 (103)
	United States			
1970–75	0.85	0.66 (78)		
1975–80	0.19	–0.26 (–136)		
1980–85	1.34	1.07 (80)		
1985–90	0.77	0.67 (87)		
1990–95	1.03	1.10 (107)		

Note: Figures in parentheses represent the percent of total change.

Price Performance

To understand the economic forces underlying the movements in quantities described above, it is useful to look at the behavior of some key relative prices.

The Real Exchange Rate

In Figure 3.2 we plot the real exchange rate:

$$e \equiv \left(CPI^{A} / CPI^{US}\right) \cdot E, \tag{3.8}$$

where CPI^i denotes the consumer price index in Argentina and in the United States and E denotes the nominal exchange rate. This definition of the real exchange rate is a proxy for the relative price on nontraded goods. For the purpose of studying the real exchange rate, the sample is broken into the subperiods 1959–74, 1982–88, and 1991–2001. We observe that the real exchange rate fell almost 20 percent in the 1980s from its value in the 1960s and early 1970s, and rose by 56 percent in the 1990s. In the subperiod 1975–81 the real exchange rate was extremely volatile due to a temporary opening of the economy in the late 1970s, and volatility also spiked in 1989–90 because of hyperinflation.

Interest Rates

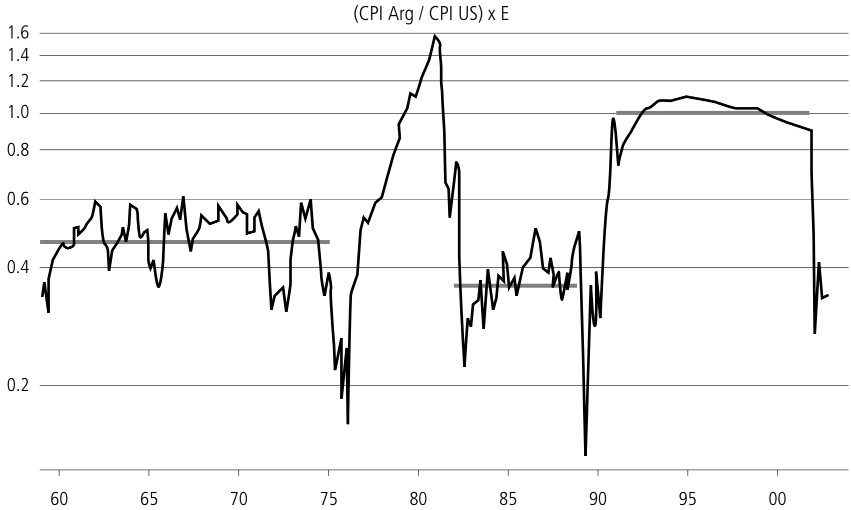
Throughout the second half of the 20th century the Argentine economy experienced repeated violations of creditors' property rights. Up to 1977, interest rate ceilings were standard, and nominal financial contracts were eroded by inflation. Credit at negative real interest rates was allocated by the government, which transferred resources from depositors to privileged debtors. These credit subsidies were part of the import-substitution indus-

Table 3.8. The Real Exchange Rate (1959–2001)

Period	Mean	St. dev.	Min	Max
1959:01–1974:12	0.48	0.07	0.30	0.61
1975:01–1981:12	0.74	0.39	0.15	1.50
1982:01–1988:12	0.39	0.09	0.22	0.76
1989:01–1990:12	0.45	0.23	0.13	0.98
1991:01–2001:12	1.00	0.07	0.72	1.09

Note: Real Exchange Rate = (CPI^{ARG}/CPI^{US}) Exchange Rate; subperiods begin in January of the first year and end in December of the latter year.

Figure 3.2. Relative Price of Services



trialization policy. In 1977, financial markets were liberalized and real interest rates rose. Rates increased further after Argentina defaulted on its public debt in the early 1980s. Our analysis focuses on this period.

Real interest rates in Argentina are hard to measure since regulations make local interest rates hard to interpret and the volatility of inflation makes measuring expected inflation tricky. For the period 1983–97 we use the measure of interest rates in Alvarez and Neumeyer (1999), which was used successfully to explain Argentine business cycles in Neumeyer and Perri (1999). The average annual interest rates for 1983–90 and for 1991–97 were 22 percent and 10 percent, respectively.

Relative Price of Imports and Exports: Trade Policy 1950–2000

The protectionist policies of the last century relied on a complicated battery of instruments. Our analysis turns to providing a summary measure of protection by using a trade policy index to capture the way these policies affected the relative price of imported goods as well as how they affected the cost of capital and investment.

From 1950 to 1976, Argentina continued to pursue the development strategy of import-substitution industrialization that had begun in the 1930s and been reinforced in 1943. This strategy was supported through commercial policy, exchange rate controls, the tax structure, and credit subsidies. In the first stage, one stimulated creation of industries that replaced imports of final goods; in later stages, one protected intermediate inputs and capital goods, including cars, steel, and petrochemicals. A window of trade liberalization cracked open in 1976–81, only to be closed again in the 1981–91 period. Actual dismantling of the protectionist regime started in 1988 and was consolidated in the 1990s. This section describes Argentina's trade and exchange rate policies and constructs an index that is used as a summary statistic of Argentina's trade policy stance.

A battery of instruments was used to channel resource flows to industries replacing imports. Such policies included export taxes; price ceilings on exportable goods; import tariffs; quantitative restrictions on imports; export subsidies for nontraditional exports; multiple exchange rates, with higher rates for imports and "nontraditional" exports and lower rates for exportable goods; and credit subsidies favoring import-competitive industries.

Table 3.9 shows that Argentina mainly exports agricultural goods. Agriculture's share of total exports was 93 percent in 1963, 85 percent in 1970, and 71 percent in 1980. Moreover in 1980, after over 40 years of import substitution, only 23 percent of exports involved manufactured goods.

Table 3.9. Composition of Exports
(in percent)

	Agr. raw material	Food	Fuel	Ore and metals	Total agriculture	Manufactures
1963	20	72	1	1	93	6
1970	11	74	0	0	85	14
1980	6	65	3	2	71	23
1990	4	56	8	2	61	29
1997	3	49	12	2	52	34

Source: World Development Indicators (1999).

Given the composition of exports, the combination of all distortionary policy interventions will be summarized by the trade policy index (TPI):

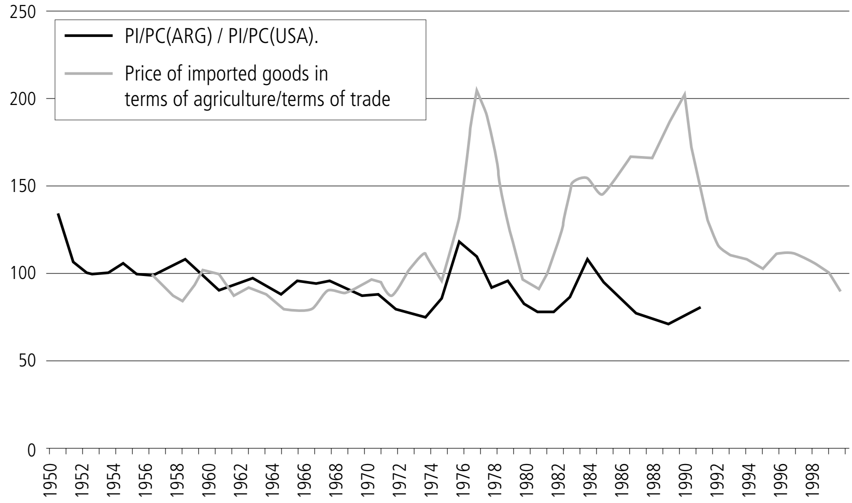
$$\text{TPI} = \frac{\dfrac{\textit{Domestic Price of Imported Goods}}{\textit{Domestic Price of Agricultural Goods}}}{\dfrac{\textit{International Unit Price of Imports}}{\textit{International Unit Price of Exports}}} = \frac{E_m(1+\tau_m)}{E_x(1+\tau_x)} \qquad (3.9)$$

where E_m/E_x is the ratio of the exchange rate applicable to producers of goods *m* and *x*, respectively, when there are multiple exchange rates. Our preferred strategy for measuring trade policies, then, is pegged to relative prices.

The broken line in Figure 3.3 shows the value of this index for the period 1956–99. It shows that the trade policy index remained fairly stable despite the apparent volatility of policies during the 1950s and 1960s. This changed in the 1974–76 period due to the imposition of quantitative restrictions, export taxes, and multiple exchange rates. Figure 3.3 also shows the short-lived trade liberalization experiment of 1977–80, the strongly protectionist policies of the 1982–89 period, and the trade liberalization of the 1990s. According to the trade policy index the level of protection in the 1990s was similar to that of the 1950s and 1960s. This is at odds with data on the composition of imports that show a rise in consumption goods and with data on legal tariffs. A possible explanation may lie in the fact that by the 1990s, agricultural goods only comprised 52 percent of exports due to the increase in exported oil and manufactured goods, making the index measurement of export prices susceptible to error.

The solid line shows the ratio between the relative price of investment goods in terms of consumption goods in Argentina and the United States. Changes in this variable can be interpreted as changes in distortions to investment, such as import tariffs on capital goods. The graph shows that the relative price of investment goods in Argentina peaks in 1975 and 1983, and these peaks coincide with protectionist episodes.

Figure 3.3. Trade Policy Index and Relative Price of Investment Goods



Sources: The relative price of investment goods is from the Penn World Tables. An index value of 100 corresponds to a true value of 2. Domestic relative prices are from the wholesale price index and the terms of trade are from Berlinski (2000).

Summary of Facts

In the period 1950–75 Argentina was on a balanced growth path. Income per capita was growing at approximately the same rates as in the United States and the rest of Latin America. The growth accounting exercise shows that most of this growth was capital deepening, and the shift-share analysis shows that labor reallocation played a small role. Prices during this period were relatively stable as shown by the real exchange rate and the trade policy index.

In 1975–90, output per worker falls at an average annual rate of 1.09 percent. Argentine income per capita plunged 50 percent relative to the U.S. and the rest of Latin America. This growth implosion was driven by a fall in capital per worker of 0.7 percent yearly and by a puzzling average decrease in TFP of 1.67 percent yearly. Human capital during this period was 1.43 percent per year. Analysis shows a considerable reallocation of labor during this period from sectors with growing output per worker to a sector in which output per worker was falling. These movements in the labor force account for 44 percent of the decline in output per worker. During this period the cost of capital, as measured through interest rates and the relative price of investment goods, was higher than in the other two periods. The relative price of services, on the other hand, was lower and more volatile than in the previous and the following periods. Our measure of protection, the trade policy index, was higher and much more volatile than in the other periods.

In the 1990s growth was restored, with capital per worker and total factor productivity growing as well. Labor reallocation was important, accounting for 56 percent of growth, and labor was flowing to sectors with rising output per worker. Real interest rates, as well as the relative price of investment goods, fell relative to the 1980s, while the relative price of services was higher.

Capital Stagnation and Reallocation

The previous section shows that capital stock fell, all new entrants to the labor force were employed in the service sector, and the relative price of services decreased during the Argentine Great Depression. This section provides a simple model to interpret these facts.

Our main hypothesis is that a bad investment environment produced a stagnant capital stock, which in turn induced the labor reallocation observed in the data. The main underlying assumption is that it is harder to substitute labor for capital in the tradable sector of the economy (agriculture, mining, and manufacturing) than in the nontradable one (services). In the extreme case, in which tradable goods are produced with a Leontieff technique and services are produced with a Cobb-Douglas one, a labor force increase is fully absorbed by the Cobb-Douglas sector and results in a declining relative price for goods in this sector, declining wages, and an increasing return to capital.

The easiest way to illustrate this point is to consider an economy with two goods: T and N. Preferences are described by

$$U = \mu \ln T + (1 - \mu) \ln N, \qquad (3.10)$$

and technology is described by the following functions:

$$Y_T = \phi \min(\alpha_T K_T, L_T), \text{ and} \tag{3.11a}$$

$$Y_N = A_N K_N^{\alpha_N} L_N^{1-\alpha_N}, \tag{3.11b}$$

where T and N denote the production and consumption of goods T and N; K_i denotes capital employed in sector i; L_i is the labor employed in sector i; and ϕ, α_N, A_N, and μ are parameters.

Given K_T, K_N, an equilibrium consists of the prices p_N, r_n, w and the quantities L_N, N, and T for which consumers optimize and markets clear. Using the optimal labor demand in the T sector, market clearing in the labor market, $L_N + L_T = L$, is equivalent to

$$L_T = a_T K_T, L_N = L - a_T K_T, \tag{3.12}$$

where L is the labor force.

The relative prices in this economy, derived from the market-clearing conditions in labor and output markets, and in the optimization conditions, are

$$\frac{p_N}{p_T} = \frac{1-\mu}{\mu} \frac{\phi a_T K_T}{A_N K_N^{\alpha_N} \left(L - a_T K_T\right)^{1-\alpha_N}}, \tag{3.13a}$$

$$\frac{w}{p_T} = \left(1-\alpha_N\right) \frac{1-\mu}{\mu} \frac{\phi a_T K_T}{L - a_T K_T}, \text{ and} \tag{3.13b}$$

$$r = \alpha_n \frac{1-\mu}{\mu} \frac{\phi a_T K_T}{K_N}. \tag{3.13c}$$

Observe that, for a given capital stock, an increase in the labor force results in a decrease in the relative price of the N good and a fall in real wages. The elasticities of the relative price of N and of real wages with respect to L are

$$\frac{d\log(p_N/p_T)}{d\log L} = -(1-\alpha_N)\frac{L}{L_N}, \qquad (3.14a)$$

$$\frac{d\log(w/p_T)}{d\log L} = -\frac{L}{L_N}. \qquad (3.14b)$$

These simple equations show that in an economy with the technology (3.11a/3.11b), if the capital stock is fixed, an increase in the labor force will induce a drop in the relative price of services and of real wages. Using the share of employment in services in 1970 and a labor share of 0.7 for the service sector, the elasticity of the relative price of services with respect to the labor force is –1.2 and the elasticity of real wages is 1.75.

In this simple example it is also easy to see that for a given capital stock a shift-share analysis, with base year prices, would result in the following decomposition of output per worker:

$$\frac{\Delta y}{y} = \underbrace{\left(\frac{p_T Y_T}{Y}\frac{\Delta y_T}{y_T} + \frac{p_N Y_N}{Y}\frac{\Delta y_N}{y_N}\right)}_{within} \qquad (3.15)$$

$$+ \underbrace{\left(\frac{\Delta l_T}{l_T}\frac{p_T Y_T}{Y} + \frac{\Delta l_N}{L_N}\frac{p_N Y_N}{Y}\right)}_{between}$$

$$+ \underbrace{\left(\frac{p_T Y_T}{Y}\frac{\Delta l_T}{l_T}\frac{\Delta y_T}{y_T} + \frac{p_N Y_N}{Y}\frac{\Delta l_N}{l_N}\frac{\Delta y_N}{y_N}\right)}_{interaction}.$$

An increase in the labor force with a given capital stock will result in a negative within term equal to

$$-\frac{p_N Y_N}{Y}\alpha_N L/L_N \hat{L}. \qquad (3.16)$$

The between term will be equal to

$$\left(\frac{p_N Y_N}{Y} - \frac{p_T Y_T}{Y}\right)\left(1 - L_N/L\right)\hat{L}, \tag{3.17}$$

which is positive since the service sector of the economy is larger than the tradable one. The interaction term will be

$$-\frac{p_N Y_N}{Y}\alpha_N\, L/\left(L/L_N - 1\right)\hat{L}. \tag{3.18}$$

Using 1970 data,

$$p_N Y_N/Y = L_N/L \cong 0.57 \text{ and } \alpha_N = 0.7, \tag{3.19}$$

implying that the within term is $-0.7\hat{L}$, the between term is $0.06\hat{L}$ and the interaction term is $-0.52\hat{L}$. Since all the new labor goes to the *N* sector, the reallocation effects become smaller over time as L_N converges to *L*. These back-of-the-envelope calculations, in which the within term accounts for 60 percent of the change in output per worker, are qualitatively consistent with the data in Table 3.6 where the within term accounts for 56 percent of the fall in output per worker.

Observe that a Solow-type growth accounting exercise here will correctly decompose the fall in output per capita, implying that the reallocation of labor does not explain the fall in total factor productivity.[4]

Accounting for the Fall in Capital Stock Per Worker

Previous sections documented the rise in interest rates and the increased protection experienced during 1975–90. Here we evaluate their impact on

[4] $\left(\frac{\Delta Y}{Y}\right) = (1-\alpha)\frac{1-\mu}{L_{N/L}}\hat{L}$ and $\frac{\omega L}{Y} = (1-\alpha)\frac{1-\mu}{L_{N/L}}$.

the stock of capital per worker, using the framework of the standard neoclassical growth model.

Rising Interest Rates

The effect of changes in the relative price of investment goods and in the interest rate is calculated with the methodology described in Hopenhayn and Neumeyer (in Part III of this volume). The expression for the equilibrium capital stock implies that the elasticity of the capital stock with respect to the interest rate is

$$\frac{\partial k_i}{\partial r}\frac{r}{k_i} = -\frac{1}{1-\alpha_i}\frac{r}{r+\delta}. \tag{3.20}$$

The average annual interest rates for 1983–90 and 1991–97 were 22 percent and 10 percent, respectively. As this is also the interest rate that Kydland and Zarazaga (2002) calibrated for Argentina's steady state, we assume that Argentina's rate before 1974 was also 10 percent. Following Kydland and Zarazaga we set the depreciation rate at 9 percent. Using these parameter values, the elasticity of the capital-labor ratio with respect to the interest rate in the mid-1970s was 0.17. This implies that a 100 percent increase in the interest rate should result in a fall in capital stock of 17 percent. As the index of the capital-labor ratio in 1991 was 34 percent lower than the average value for the 1962–84 period (39 percent lower than its 1981 value), we conclude that interest rates explain up to half of the decline in Argentina's capital-labor ratio. The value of the elasticity in the 1980s, when interest rates were around 20 percent, is –0.3; hence a 50 percent drop in the interest rate would induce a rise in the capital-labor ratio of 15 percent, which is actually very close to the 13 percent increase observed between 1991 and 1997.

The Direct Impact of Trade Policies on Investment

In order to evaluate the effects of trade policies on the steady-state equilibrium capital stock with respect to tariffs, it is necessary to distinguish between tariffs on capital goods, *I*, which reduce investment, and tariffs on final goods that increase investment. The expression for the equilibrium capital stock in each sector implies that the elasticities of the capital stock in each sector with respect to tariffs on investment goods (τ_I) and with respect to protective tariffs (τ_i) are

$$\frac{\partial k_i}{\partial \tau_I}\frac{\tau_I}{k_i} = -\frac{1}{1-\alpha_i}\frac{\tau_I}{1+\tau_I} \text{ and } \frac{\partial k_i}{\partial \tau_i k_i} = \frac{1}{1-\alpha_i}\frac{\tau_i}{1+\tau_i}. \tag{3.21}$$

Assuming investment goods are imported, the direct effect of tariffs on the producers of imported goods is nil since the negative effect of the tariff is offset by increased protection. For the other two sectors, our evidence suggests that tariffs on capital goods in the 1974–90 period were twice those in 1960–74. This is inferred from the doubling of protection implied by the trade policy index in Figure 3.3, which can also be seen in Table 3.10.

The implicit tariff rate in the tariff revenue to total imports ratio increased from 10 percent in 1973 to 20 percent in 1980 and 1986. Given that our measure of the elasticity of the capital-labor ratio with respect to tariffs on capital goods is 0.15, the estimated fall induced in the capital-labor ratio in these sectors by the increase in tariffs is 15 percent. Since services and primary products account for about two-thirds of output, assuming the share of the capital stock in these sectors equals the share in output, the fall in the aggregate capital-labor ratio stemming from the tariff on investment goods is 10 percent.

There is still a 10 percent decline in capital stock that needs to be explained. Potential reasons include higher export taxes (little likelihood since primary products account for a small share of GDP), removal of credit

Table 3.10. Trade Policy Index

1960–1965	72.47	1981–1985	149.12	1960–1974	75.32
1966–1970	77.21	1986–1990	176.29	1975–1990	149.50
1971–1975	88.07	1991–1995	126.84	1991–2000	117.52
1976–1980	126.69	1996–2000	108.21		

subsidies in import-competing sectors, and expectation of policy reversals, especially in the protected import-competing sector.

A Model for Uncertain Protection, Growth, and Resource Allocation

This section sketches a model that tries to capture features of the Argentine economy essential to understanding the Great Depression of the 1980s. We need to explain the fall in aggregate output per worker, why capital per worker dropped, and why the employment share increased in sectors with declining productivity and decreased in sectors with rising productivity. The model will then be used to quantify the effects of expected policy reversals.

In a standard neoclassical growth model, policies and distortions can explain only the change in capital per worker but not the changes in employment shares underlying the decline in total factor productivity. Hence departures from the standard one-sector growth model are necessary. Thus our model assumes (1) that investment is irreversible, (2) that protectionist policies may become unsustainable enough for agents to expect that trade liberalization will occur,[5] and (3) that there is less substitutability between factors of production in the tradable than the nontradable sector.

The irreversibility of investment, combined with the expectation of a trade reform, implies that the investment cost should also include an option value for waiting that captures the expected capital loss of installed capital arising from trade liberalization. In the protected sectors a move toward free trade devalues installed capital by reducing the present value of future profits; in the competitive sectors free trade lowers the value of imported capital that is imported freely after the reform. We show that the effects of these two assumptions can be significant.

[5] In particular, we consider the effect of increasing the probability of a drastic change in trade policy that would end protection. Indeed during the 1990s protection *was* substantially curtailed in many Latin American economies. Moreover Argentina had already experienced in the mid-1970s a period of substantial tariff reductions and currency appreciation that lowered import prices considerably.

The assumption about factor substitutability implies that when government policies reduce the equilibrium capital-labor ratio, labor will flow from the more rigid to the more flexible sectors. To be precise, we consider an economy that produces two tradable consumption goods (x and m), a tradable investment good (i), and a nontraded consumption good (n). The technology to produce each of the goods is described by the following production functions:

$$x = \min\left(a_x K_x, l_x\right) \tag{3.22a}$$

$$m = \phi_m \min\left(a_m K_m l_m\right) \tag{3.22b}$$

$$i = \phi_i \min\left(a_i K_i l_i\right) \tag{3.22c}$$

$$n = A_n K_n^{\alpha} l_n^{1-\alpha}. \tag{3.22d}$$

Tradable goods are produced with a Leontieff technology while services are produced with a Cobb-Douglas one. The idea is that in the nontradable sector—mainly services—there is more scope in substituting labor for capital. Consequently, if the desired capital stock falls in the tradable sectors, labor will flow from them to the nontraded sector. As the marginal product of labor is decreasing in labor and capital in this sector falls, output per worker in the nontraded sector falls. Therefore, this flow of resources shows up as a negative interaction term in the shift-share decomposition presented in (3.6).

The capital accumulation technology is

$$\dot{K}_j\left(s_t\right) = i_j\left(s_t\right) - \delta K_j\left(s_t\right) \text{ for all } j = x,\ m,\ n,\ i \text{ and} \tag{3.23}$$

$$i_j\left(s_t\right) \geq 0 \text{ for } j = x,\ m,\ n,\ i, \tag{3.24}$$

where K_j is the stock of capital in sector j and δ is the instantaneous rate of depreciation. The nonnegativity of investment is capturing the irreversible nature of investment previously mentioned.

The international prices of the tradable goods are normalized to be

$$p_x^* = p_m^* = p_i^* = 1,$$

and the international risk-free interest rate is assumed to be r. Under these assumptions there is complete specialization in production, and we assume that under free trade it is inefficient to produce goods m and i. This requires restricting the technological parameters to satisfy

$$\phi_m < 1 + \left(\frac{1}{a_m} - \frac{1}{a_x}\right)(r+\delta) \tag{3.25}$$

$$\phi_i < 1 + \left(\frac{1}{a_m} - \frac{1}{a_x}\right)(r+\delta). \tag{3.26}$$

Under a protectionist regime, tariffs τ_m and τ_i are levied on goods m and i so that it becomes profitable for domestic firms to produce these goods at home. For simplicity we assume that tariffs are prohibitive. The domestic price of imported goods then is

$$1 \le p_m \le 1 + \tau_m \text{ and } 1 \le p_i \le 1 + \tau_i. \tag{3.27}$$

The expectation of a trade reform under protection implies that the protectionist policy is uncertain since tariffs may be removed. The state of the economy (s) is equal to P if there is protectionism or F if there is free trade. At any instant, the probability that the protectionist regime will end and there will be a switch to free trade is λ.

Household preferences are given by

$$E\left[\int_0^\infty u\left(x(s_t), m(s_t), n(s_t)\right)e^{-rt}dt\right], \tag{3.28}$$

where r is the household's discount rate, which is assumed to equal the international interest rate, and u is an additive logarithmic function.

The private sector's problem is to maximize (3.28) subject to the capital accumulation (3.23) and irreversibility (3.24) constraints; the household's budget constraint,

$$\begin{aligned}\dot{b}(s_t) &= r(s_t)b(s_t) + a_x K_x(s_t) + p_m \phi_m a_m K_m(s_t) + p_n(s_t) f(K_n(s_t), l_n(s_t)) \\ &+ p_k(s_t)\left[\phi_i a_i K_i(s_t) - \left(i_x(s_t) + i_m(s_t) + i_n(s_t)\right)\right] + \tau \\ &- \left[x - (s_t) + p_m(s_t) m(s_t) n(s_t)\right];\end{aligned} \quad (3.29)$$

and the labor constraint,

$$0 = l - a_x K_x(s_t) - a_m K_m(s_t) - a_i K_i(s_t) - l_n. \quad (3.30)$$

The first constraint is the household's budget constraint (3.29). The private sector accumulates bonds denominated in the export good, which pay an interest rate $r(s_t)$ from the income of producing the four goods, interest income, and government transfers (τ) net of the expenditures in consumption and investment. The capital accumulation and irreversible investment constraints are standard. The constraint on labor uses the fact that if labor is optimally set,

$$l_x = a_x k_x(s_t),\ l_m = a_m k_m(s_t) \text{ and } l_i = a_i K_i(s_t). \quad (3.31)$$

The government budget constraint is

$$\tau = \tau_m \max\left[\left(m - \phi_m a_m k_m(s_t)\right), 0\right] + \tau_i \max\left[\left(i - \phi_l l_i\right), 0\right]. \quad (3.32)$$

For simplicity we assume that under protection the country has no access to loans from the rest of the world and under free trade it faces an inelastic supply of loans at the international interest rate. Therefore, aggregate consistency in financial markets requires that under protection $\dot{b} \geq 0$ and under free trade $r^F = r$.

In the nontraded goods sector, aggregate consistency requires that

$$n(s_t) = f(K_n(s_t), l_n(s_t)). \tag{3.33}$$

For an interior solution, the first-order conditions for capital accumulation in sectors $j = x$, m, and i under free trade and protection satisfy[6]

$$r + \delta = a_j(\phi_j - w^F) \tag{3.34}$$

under free trade and

$$(r + \delta)p_i^P = a_j(p_j^P \phi_j - w^P) + \lambda\left(\frac{u_x^F}{u_x^P} - p_i^P\right) \tag{3.35}$$

under protection.

These first-order conditions state that the marginal cost of investing an extra unit of capital in sector j has to equal the marginal benefit. Under free trade, the investment good price is $p_i^F = 1$, so the cost of capital is $r + \delta$. With the Leontieff technology, the marginal gain of an additional unit of capital is the marginal product of capital, $\phi_j a_j$, net of the cost of hiring a_j additional units of labor. Under protection, the cost of capital is higher since its price is higher. The expected marginal profit of capital is smaller due to the expected capital loss that occurs if there is trade liberalization. The capital loss is equal to the difference between the value of a unit of capital if there is a trade reform in terms of the x good under protection u_x^F / u_x^P and the price of capital under protection, p_i^P. Observe that increases in the probability of a trade reform reduce the incentives to invest.

[6] Outside of steady state the foci are:

$$(r + \delta)q_j^P = a_j(p_j^P \phi_j - w^P) + q_j^s\left(\frac{\dot{q}_m^P}{q_m^P} + \frac{\dot{u}_x^P}{u_x^P}\right) + \lambda\left(\frac{u_x^F}{u_x^P} - q_j^P\right) q_j^s \leq p_i^s;\;\; i_j^s \geq 0;\;\; (p_i^s - q_j^F)i_j^F = 0.$$

In the nontradable sector the analogous conditions under free trade are

$$r+\delta = p_n^F \frac{\alpha A_n}{k^{1-\alpha}} \tag{3.36}$$

and

$$\left(r+\delta\right)p_i^P = p_n^P \frac{\alpha A_n}{k^{1-\alpha}} + \lambda\left(\frac{u_x^F}{u_x^P} - \left(1-\tau_i\right)\right) \tag{3.37}$$

under protection, where the term $\alpha A_n / k^{1-\alpha}$ represents the marginal product of capital in the n sector. Finally, the first-order conditions for labor in the n sector are expressed by

$$p_n^s\left(1-\alpha\right)A_n k_n = w^s. \tag{3.38}$$

Observe that expectations of policy reversals, in this example increases in λ, reduce the incentives to invest.

Testing the Model

Some preliminary experiments were performed to check the model's potential to shed light on the Argentine experience. The steady state of an economy with protection and no probability of trade reform was compared with the steady state of an economy with a 5 percent probability of trade reform and with a free trade economy. The emergence of uncertainty about the stability of the protectionist regime is one way of introducing a higher cost for capital. The 5 percent probability of trade reform implies an expected timeframe for occurrence of 20 years.

The model was calibrated to set the risk-free interest rate at 5 percent and the capital share in the production of the exported good at 0.65 percent, which accords with the agricultural labor share in Argentina. For the import-competing consumption goods and the capital goods sectors we assume $a_m = 2a_x$ and $a_i = 4a_m$. The parameters ϕ_m and ϕ_i are set to 0.45 and 0.3, respectively, and imply a 50 percent excess cost in the m sector and a 45 percent excess cost in the *i* sector. The labor share in the *n* sector is set to two-thirds, and A_n equals one-half. The utility function is set to

$$u = 0.3\log x + 0.2\log m + 0.5\log n. \quad (3.39)$$

Table 3.11a shows how aggregate variables react to the higher capital costs created by uncertainty about the survival of a protectionist regime. The first column reports the equilibrium allocation when there are prohibitive tariffs and no expectation of a policy reversal. In the second column, government policy is the same as under protection, but agents think that there is a 5 percent chance of trade liberalization. The last column corresponds to the allocation under free trade.

The effect of the expectation of a policy reversal in this example is large and consistent with Argentina's 1975–90 experience. When λ increases to 5 percent, capital stock declines in all sectors, with aggregate capital stock falling by 24 percent. This confirms the intuition that expectations of policy reversals can generate large changes in relative prices that significantly reduce demand for capital when investment is irreversible.

The table shows that GDP, measured at market prices, drops by 24 percent when a 5 percent chance of trade reform is introduced. Gains from switching to a free trade regime are very large (due to the extreme assumptions on technology and international prices). If we fix relative prices at their certain protection levels, GDP falls by only 12 percent. The difference between the two measures of GDP is due to the fact that exports are used as the numeraire and the relative price of nontraded goods falls when the cost

Table 3.11a. Simulation Results for Aggregate Variables

	Certain protection	Uncertain protection[a]	Free trade
GDP	100	76	173
TFP	100	86	115
K	100	76	251
K share	0.452	0.549	0.446
GDP_0		88	181
TFP_0		99	93

[a] Five percent chance of trade reform.

of capital increases. Total factor productivity is computed using an aggregate Cobb-Douglas technology with a capital share of 0.452, which is the capital share of the model economy under certain protection. The table shows that TFP at constant prices (as it is measured in the Argentine national income accounts) barely moves. These aggregate growth accounting experiments imply a 12 percent drop in output at prices of the certain protection regime, and the decline in capital per worker implies an 11 percent output drop. Thus the model performs well in explaining the decline in capital per worker but fails to account for the TFP fall observed in the data. The distortion introduced by the fact that the marginal product of capital is different across sectors is quantitatively unimportant. The simulated capital stock confirms this since the increase in λ induces a fall in the capital stock that is roughly proportional across sectors. This exercise is available upon request from the authors.

The model does better in accounting for changes in labor allocation and relative prices. As in the basic growth model used earlier in the chapter, the interaction between the assumptions on technology and the declining capital stock per worker induces a labor reallocation similar to that observed in the data. In this simple experiment, the rise in capital costs caused by the increase in λ induces 12 percent of the workforce to move to the nontraded sector.

Applying the shift-share analysis to the simulated data, we find that the within change induced by the increase in λ accounts for 56 percent of the output drop. The between effect and the interaction effects are both negative and account for the remaining 44 percent of decline in output per worker.

Table 3.11b. Simulation Results for Labor Allocation
(in percent)

	Certain protection	Uncertain protection	Free trade
l_x	11	9	62
l_m	12	9	0
l_i	30	2	0
l_n	47	59	38

Table 3.11c. Simulation Results for Price Effects

	Certain protection	Uncertain protection	Free trade
p_n	85	65	100
w	26	16	35
p_i	114	101	100

Price effects are summarized in Table 3.11c. As a result of introducing uncertainty, which reduces the capital per worker and detours resources to the nontraded sector, the product price falls 2 percent and real wages decline by 37 percent. Trade reform, on the other hand, induces a 50 percent rise in the relative price of good *n* and an increase in real wages of 117 percent. These price movements are consistent with the Argentine experience of the 1980s, when labor and nontraded goods were cheap, and with the 1990s, when their value increased.

Thus in this model uncertainty about government policies is responsible for all of the loss in output since nothing else changes. Expectations of policy reversals create a deleterious business environment that induces capital per worker to fall (since installed capital is hard to unbolt) and a labor reallocation toward the service sector.

Conclusion

This chapter has examined Argentina's Great Depression of the mid-1970s and 1980s in some detail. A standard Solow growth decomposition shows that factor accumulation explains only one-fourth of the lack of growth during this period. The rest remains unexplained. During the period 1975–90, there also was a tremendous reallocation of labor, with 20 percent of the labor force shifting from agriculture and manufacturing toward the service sector. We believe that a large jump in capital costs caused the observed drop in investment and contributed to the reallocation of labor.

The big puzzle is explaining why total factor productivity fell an average of 1.67 percent yearly for 15 years. In our view, the tremendous workforce reallocation that occurred may be related to the fall in productivity, thereby hiding the role played by low capital investment. We showed in an example that, absent other distortions, the change in employment structure observed in the data cannot account for the drop in TFP. Exploring the connection between these two phenomena remains a question for future research.

What caused the large rise in capital costs during this period? Our analysis shows that much of the jump can be explained by an increase in tariffs and nontariff barriers and the high interest rates that followed the default in the early 1980s. But even if one believes international lending ceased during this period, high local interest rates must still be explained. One reason could be the expectation of bank runs or the confiscation of deposits, which occurred twice during the 1980s. An alternative cause, which we explore in this chapter, is the anticipation of future capital losses. In this model capital losses are associated with a reversal in trade protection policy that triggers falling relative prices for imports.

Our simulations suggest that if investment is irreversible (putty-clay), small changes in expectations can prompt a large increase in capital costs. This could lead to a collapse in investment or at least to a significant drop in capital-labor ratios and a large reallocation to more labor-intensive sectors, as observed in the data. Moreover, our model predicts a substantial decrease in wages that partly compensates for the rise in capital costs and is necessary to encourage investment. During the 1980s, real wages did not fall as the model predicted, but investment collapsed. Meanwhile, government employment rose. If the new employment helped brake falling wages, it may be partly responsible for the investment collapse.

The model we have considered is overly simplistic and obviously omits many important elements. Yet it provides a plausible alternative story to Kydland and Zarazaga's (2002) one-sector neoclassical growth model. Further work is needed to fill in the quantitative blanks and evaluate the story's merit.

Appendix 3.A

Estimates of Human Capital Growth

The following procedure was used to construct the human capital series. Using X_{it} to denote a vector of characteristics of worker i at time t, let

$$H_{it} = \beta X_{it}, \qquad (3.A.1)$$

where β is a vector of weights estimated according to the procedure indicated below. H_{it} is a measure of the human capital of worker i. The population H_t is obtained by computing an average of the sample values H_{it}.

Data. All estimates were obtained using the household survey for the Federal District and Greater Buenos Aires area. The survey currently is held semiannually (in May and October). Only the October surveys were available for 1980–86. For the remaining years both surveys were used. An incomplete survey with no wage information was also available for 1974.

Estimates. The coefficients β were estimated through a wage regression, pooling all surveys available from 1980 onward. Sample selection was controlled by jointly estimating a participation equation (Heckman, 1979). Consistent standard errors were obtained using Greene (1981).

The following covariates were used in both participation and wage equations: age, dummies for sex and five schooling levels (Esc 1–5: completed elementary, incomplete high school, completed high school, incomplete college, completed college), and dummies for each of the surveys.

Estimates for the human capital parameters in the ln wage equation are given in Table 3.A.1.

Table 3.A.1. Estimates of Human Capital Parameters

Variable	DF	Estimates	Standard error	*t* value	Pr > l *t* l
Intercept	1	4.51186	0.16029	28.15	< .0001
Age	1	0.01093	0.00021509	50.81	< .0001
Sex (male = 1)	1	0.68367	0.03410	20.05	< .0001
Esc 1	1	0.62498	0.05908	10.58	< .0001
Esc 2	1	0.74869	0.05288	14.16	< .0001
Esc 3	1	1.19538	0.07474	15.99	< .0001
Esc 4	1	1.29406	0.07494	17.27	< .0001
Esc 5	1	1.85703	0.09293	19.98	< .0001

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CHAPTER 4

Brazilian Economic Growth, 1900–2000: Lessons and Policy Implications

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Brazil's growth pattern during the 20th century is unique in more than one way. Until 1980, Brazil was among the fastest-growing economies in the world (Maddison, 1995). Yet this growth was achieved with a mix of policies frowned upon by today's economic consensus: low regard for price stability, high protection against imports, and widespread state intervention in the economy. The same policy set was in place for most of the 1981–93 period, when Brazilian GDP growth was not only much lower, falling behind world and Latin American averages, but also more irregular than in the previous 50 years.

The economy underwent significant structural changes during the 1990s, changes that transformed Brazil from inward-oriented, inflation-prone, and crisis-vulnerable to open, price-stable, and economically well managed. But Brazil's recent efforts to integrate itself into the world economy, establish macroeconomic stability, and rely on private enterprise rather than state planning as the engine of economic growth have met with limited success as measured by GDP growth.

Whether these reforms will be sufficient to generate GDP growth rates in the longer term comparable to those that Brazil enjoyed before

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1980 is still an open question. Our hypothesis is that such growth will require further improvements, which are now possible given Brazil's new, more stable environment. Indeed some of these improvements—higher capital productivity associated with longer-term, more transaction-specific investments and greater innovation; greater investment in skills and training; and the reform of institutions governing business activity—have only been imaginable under the clearer ground rules engendered by macro stabilization. To achieve these improvements, further reforms are necessary in government, policies, and institutions. Naim (1995) calls this second stage of reform *consolidation* and notes that, in contrast to the first stage, technical and political complexities are higher when reforms are launched, depending on a larger and more diverse set of actors. This underlines the need for political consensus about the necessity and content of these reforms, which has clearly been lacking in Brazil recently.

Thus a better understanding of Brazil's paradoxical growth pattern during the 20th century may not only improve policy formulation but also help generate political support for its implementation. Any proposal for deepening the reform process in Brazil will not win wide acceptance if it is not perceived to respond to a credible account of how policies that are "wrong" in 2001 appeared "right," and indeed seemed to work so well, for half of the last century.

With this context in mind, this chapter addresses three overarching questions. First, how did Brazil manage to grow so rapidly from 1930 to 1980 while following so many "wrong" policies? Second, why did Brazil then perform so poorly in the final two decades of the century? And third, considering developments in both the domestic and international arenas, how should current public policy priorities be set to maximize Brazil's potential sustainable growth rate?

Analysis will proceed in four stages. First, we will look at the aggregate performance of the Brazilian economy during the period 1930–2000, estimating its supply-side sources of growth and relating the results to the policy framework adopted in each period. The next two sections will examine micro evidence from firms and households, respectively, and determine whether these patterns are consistent with the macroeconomic observations noted in our initial analysis. A final section will sum up the main findings and detail the policy and political-economy implications.

A Long-Term View from Aggregate Indicators

Overview

Despite the slowdown in its last two decades, the 20th century was a period of rapid change and exceptionally high growth in Brazil. As Table 4.1 indicates, both population and GDP growth accelerated after inauguration of the Republic in 1889. In particular, per capita GDP growth trebled during the Oligarchic or Old Republic when compared with the Empire period, and showed a six-fold increase when compared to the 320 years of colonial rule.

Yet this favorable record would only be a prelude to the remarkable growth of the following 50 years, starting with the 1930 Revolution and ending with the second oil shock and the debt crisis of the early 1980s. In this period, population, GDP, and per capita GDP growth rates were higher

Table 4.1. GDP, Population, and Per Capita GDP Growth in Brazil (1500–2000)

		Growth rates (%)		Per capita GDP[a]	
Period	Characterization	Population	GDP	Growth rate (%)	% of U.S. per capita GDP (end of period)[b]
1500–1820	Colony	0.47	0.62	0.15	51.4
1821–1890	Empire	1.65	1.95	0.30	23.4
1891–1929	Oligarchic Republic	2.18	3.13	0.92	16.5
1930–1980	*Desenvolvimentista* Era	2.62	5.72	3.03	28.0
1981–1993	Very High Inflation Period	1.87	1.48	–0.39	20.8
1994–2000	Low Inflation/Adjustment Era	1.38	3.05	1.65	19.3
1500–2000		1.04	1.57	0.53	

Sources: Maddison (2001), IBGE, and IMF.
[a] Measured in 1990 international (PPP) dollars.
[b] Maddison (2001) estimates that Brazil and the United States had the same per capita GDP ($400) in 1500.

than in any other phase of Brazilian development. The period was also unique in that Brazilian per capita GDP increased as a proportion of U.S. per capita GDP. Brazil's GDP growth performance also was remarkable compared with that of other Latin American countries and the world, and even with that of other 20th-century high achievers such as Japan and Korea (Table 4.2).

This bright performance ended in the early 1980s, and the luster did not return in the following 20 years. In 1981–2000, Brazil performed poorly not only vis-à-vis its past, but also compared with the world and Latin America. Its GDP per capita fell to a fifth of the U.S. level (in PPP terms), from a ratio of 28 percent in 1980. This deterioration is usually attributed to the poor macroeconomic and microeconomic management that characterized Brazil until the early 1990s. High inflation was accompanied by sizable trade barriers and by widespread state intervention through ownership of commercial enterprises, public monopolies, entry restrictions in a number of sectors, and a myriad of norms, regulations, and incentives aimed at directing private investment and activities. Yet this description also applies to the 1930–80 boom, suggesting it only partly accounts for the slowdown. Furthermore, since 1994 Brazil has experienced low inflation, trade liberalization, substantial privatization, and an end to much of the regulation of private activity, without restoring rapid growth (Tables 4.1 and 4.2).

Table 4.2. Comparison of Annual GDP Growth Rates (1930–2000)

Country	1931–50[a]	1951–80	1981–93	1994–2000
Brazil	4.6	6.8	1.4	3.1
Argentina	2.9	3.4	1.0	2.6
Mexico	4.1	6.4	1.7	3.1
Chile	2.7	3.4	3.5	5.6
Colombia	3.9	5.2	3.2	2.2
Korea	0.6	7.5	7.2	5.3
Japan	1.6	7.9	3.3	1.1
U.S.	3.2	3.6	2.2	3.9
Latin America	3.6	5.2	1.7	3.1
World	1.8	4.5	2.6	3.4

Sources: Maddison (1995, 2001) and IMF.
[a] Years 1930–50 for Latin America and the world.

This apparent paradox will be examined in two ways. First, a one-sector, supply-side decomposition of GDP growth is used to scrutinize expansionary sources in a number of largely homogeneous periods of the 20th century. Then we analyze the characteristics of growth and economic policy in those different periods, introducing increasing detail as the end of the century nears and using a conditional convergence model to test for possible causes of (1) the slowdown in growth in the last two decades and (2) the seemingly small impact of recent reforms. The analysis is carried out separately for the following periods:

- *1901–30*. High period of the First (Old or Oligarchic) Republic, featuring mostly orthodox policies, a primary export economy, and relatively significant integration into the world economy.
- *1930–50*. Unstructured import substitution (IS) in traditional manufactures, with low participation by state-owned enterprises (SOEs) and high dependence on coffee exports.
- *1951–63*. Structured IS in consumer durables, with increasing participation by SOEs and foreign direct investment (FDI) and ongoing dependence on coffee exports.
- *1964–80*. Expansion of IS into intermediate and capital goods, rapid growth of manufactured exports, high FDI, and continuing growth of SOEs.
- *1981–93*. An increase and then a decline in import protection and export subsidies, first steps toward privatization, low FDI inflows, and high macroeconomic instability.
- *1994–2000*. Improved macroeconomic conditions, substantial increases in import penetration, deepening privatization, and expanding FDI.

Growth Accounting

Tables 4.3 and 4.4 show GDP growth accelerating from an average of 4.3 percent yearly in 1900–30 to 7.8 percent in 1964–80, paralleling the rise in growth rates of employment and, at least since the 1930s, of physical and

Table 4.3. Annual Growth of GDP, Capital Stock, Employment, and Human Capital
(in percent)

		Capital stock					Human capital (years of schooling)		
Period	GDP	Total	Const.	Man. & equip.	Imported m. & eq.	Employment	1981 PNAD	1998–99 PNADs	Combination[c]
1901–30	4.33					1.51			
1931–50	5.14	5.30	5.87	3.74	8.29[a]	1.84	1.67		1.67
1951–63	6.88	8.67	9.08	7.14	3.64	2.81	1.75	2.49	2.11
1964–80	7.79	8.96	8.83	9.49	4.00	3.25	2.14	2.69	2.62
1981–93	1.64	2.60	3.55	–2.58	–4.59	2.17		0.52	0.52
1994–2000[b]	3.05	2.30	1.60	7.33	20.77	–0.35		0.41	0.41

Sources: See Appendix 4.A; Pesquisa Nacional por Amostra de Domicílios (PNAD).
[a] Years 1934–50.
[b] Years 1994–99 for years of schooling.
[c] Combination of 1981 and 1998–99 PNADs.

Table 4.4. Illiteracy Rates, Secondary School Enrollment Rates, and Life Expectancy (1900–98)

Year	Illiteracy (%)	Gross enrollment in secondary schools (%)	Life expectancy
1900	65.3		
1920	69.9	2.1	
1940	56.2	3.8	42.74
1950	50.0	5.8	45.90
1960	39.5	10.8	52.37
1970	33.1	26.0	52.67
1980	25.5	33.5	61.76
1981		33.2	62.76
1991	20.1	40.5	66.03
1993		42.8	66.63
1998[a]	13.8	45.0	68.55

Sources: Romanelli (1982), IBGE, and GDN database (www.worldbank.org/research/growth).
Note: Illiteracy rates are for age 15 and over.
[a]Year 2000 for life expectancy.

human capital.[2] The stock of machinery and equipment rose especially fast, partly to offset its higher rate of depreciation. Table 4.3 illustrates again the significant deceleration in GDP growth in the last two decades of the 20th century. It also shows that lower GDP growth was accompanied by equally substantial declines in the growth rate of employment and physical and human capital. The contrast before and after the Real Plan is also evident: GDP growth was lower and factor accumulation was faster beforehand, while the opposite was true afterward except for machinery and equipment, which actually declined in 1981–93 and boomed after price stabilization.

The reflection of these trends in output growth and factor accumulation on factor productivity is shown in Table 4.5. Substantial capital accumulation in 1931–80 caused a decline in capital productivity, but helped to foster a substantial rise in labor productivity, building on the already substantial increase recorded in 1901–30. The growth rate of human capital productivity also accelerated in 1931–80.

In 1981–93, capital productivity continued to decline, while growth of labor productivity dropped 5 percent and human capital fell 4.1 percent.

[2] Rates of investment (constant prices) were similar in 1900–30 and 1930–50.

Table 4.5. Annual Factor Productivity Growth
(in percent)

	Physical capital				Human capital		
Period	Total	Const.	Mach. & equip.	Labor	1981 PNAD	1998–99 PNADs	Combination
1901–30				2.8			
1931–50	–0.2	–0.7	1.4	3.3	3.5		3.5
1951–63	–1.8	–2.2	–0.3	4.1	5.1	4.4	4.8
1964–80	–1.2	–1.0	–1.7	4.5	5.7	5.1	5.2
1981–93	–1.0	–1.9	4.2	–0.5		1.1	1.1
1994–2000	0.8	1.5	–4.3	3.4		2.6[a]	2.6[a]

Source: Table 4.3.
[a] Years 1994–99 for human capital.

This was the only decline in labor productivity registered among the periods considered here. Partial factor productivity of labor and physical and human capital all rose significantly in 1994–2000. Thus total factor productivity (TFP) growth was not only positive during this time, but at least 1.5 percent higher than in 1981–93, a larger increment than for output growth. On the other hand, this means that factor accumulation in 1994–2000 was necessarily negative.

In Table 4.6 a Solow-style decomposition of output growth into factor accumulation and TFP growth (or the Solow residual) is derived. Leaving aside for now the growth in human capital, a Cobb-Douglas production function is used with physical capital (K) and labor (L) of the form

$$Y = AK^{\alpha}L^{1-\alpha}. \tag{4.1}$$

To solve for the growth rate of productivity, logs and time derivatives are taken:

$$\text{TFP} = \text{GDPGrowth} - \alpha * \text{CapGrowth} - (1-\alpha) * \text{LaborForceGrowth}. \tag{4.2}$$

The key parameter for the growth decomposition exercise, then, is the capital elasticity α, for which the literature presents varying estimates. Typical cross-country exercises, including some with Brazil as part of the sample, use values of α between 0.3 and 0.4.[3] Estimates from time series regressions with Brazilian data point to a value of α close to 0.7.[4] The national accounts, in turn, suggest a value of α between 0.48 and 0.55, depending on how self-employment income, which includes a return to both labor and capital, is allocated (IBGE, 2000). Based on this, some of the previous growth decomposition exercises for Brazil have assumed equal shares of capital and labor (i.e., α = 0.5).[5]

Regardless of the value of α, it is clear from Table 4.6 that the decline in GDP growth after 1980 was due both to a lower rate of capital accumulation and a drop in TFP growth, with the lower growth rate in employment playing a secondary role. As the value of α grows, the contribution of capital in explaining the high GDP growth in 1930–80 and its subsequent decline increases, while the contribution of TFP growth decreases. For α = 0.7, growth in capital stock explains 80 percent of GDP expansion in 1930–80 and 72.4 percent of the decline in output growth from 1964–80 to 1981–93, while TFP accounts for 8.1 percent and 22.3 percent, respectively. For α = 0.3, capital accumulation accounts for 34.3 percent of GDP growth in 1930–50 and 31.1 percent of the decline in output growth between 1964–80 and 1981–93, while TFP growth contributes plus 38 percent and minus 31.1 percent, respectively.

Table 4.6 confirms that accelerated GDP growth after price stability in 1994 was entirely due to higher TFP growth. In fact, except for low values of α, TFP growth was higher in 1994–2000 than for any previous period in the table. Indeed, low inflation and the 1990s market reforms failed to restore output growth to pre-1980 levels because those reforms failed to generate factor accumulation, with the contributions of both labor and capital to output growth actually declining in comparison to 1981–93.

Following Mankiw, Romer, and Weil (1992), our second TFP measure builds on a production function augmented to include human capital (*H*) in addition to physical capital (*K*) and labor (*L*):

[3] See, for instance, Mankiw (1995), McKinsey (1998), and De Gregorio and Lee (Appendix A).
[4] See Abreu and Verner (1997) and our estimates in Appendix 4.A.
[5] See, for instance, Bonelli and Fonseca (1998) and Bacha and Bonelli (2003).

Table 4.6. Growth Decomposition Using Solow's Model with Capital and Labor

		Brazilian elasticities (α = 0.7)			Cross-country elasticities (α = 0.3)		
Period	GDP	Capital	Labor	TFP	Capital	Labor	TFP
1931–50	5.14	3.71	0.55	0.88	1.59	1.29	2.26
1951–63	6.88	6.07	0.84	–0.03	2.60	1.97	2.31
1964–80	7.79	6.27	0.98	0.54	2.69	2.28	2.83
1981–93	1.64	1.82	0.65	–0.83	0.78	1.52	–0.66
1994–2000	3.05	1.61	–0.11	1.55	0.69	–0.25	2.61

$$Y = AK^{\alpha}H^{\gamma}L^{1-\alpha-\gamma}. \tag{4.3}$$

We use the average years of schooling of 20-year-olds as a proxy for the human capital stock in the economy. As above, estimates of TFP and of the contributions of factor accumulation to growth depend on the values of α and γ. Our Brazil time series data revealed collinearity between physical and human capital growth. Controlling for the contribution of physical capital to labor productivity growth, we find no additional statistically significant contribution from human capital growth (i.e., the hypothesis that $\gamma = 0$ cannot be rejected).[6] This contrasts with the parameter values used in Mankiw (1995), namely, $\alpha = 0.3$ and $\gamma = 0.5$, which assume that about two-thirds of labor income can be considered as return to human capital. Using Mankiw's parameter values and taking logs and time derivatives gives us the following:

$$\begin{aligned} \text{TFP} = \text{GDPGrowth} - 0.3 * \text{CapGrowth} - 0.5 * \\ \text{SchoolGrowth} - 0.2 * \text{LaborForceGrowth}, \end{aligned} \tag{4.4}$$

which, when applied to the values in Table 4.3, gives the growth decomposition in Table 4.7.

[6] The same result is obtained by Abreu and Verner (1997) with a different measure of schooling: average years of primary, secondary, and tertiary education per person over 10.

Table 4.7. Growth Decomposition with Human Capital Using Elasticities from Mankiw (1995)

Period	GDP	Physical capital	Labor	Human capital	TFP
1931–50	5.14	1.59	0.37	0.84	2.35
1951–63	6.88	2.60	0.56	1.06	2.66
1964–80	7.79	2.69	0.65	1.31	3.14
1981–93	1.64	0.78	0.43	0.26	0.17
1994–2000	3.05	0.69	–0.07	0.21	2.23

The results are not qualitatively different from earlier, reflecting the fact that even with Mankiw's high elasticity for human capital,[7] its contribution to GDP growth in 1930–2000 is small. The decline in the growth rate of schooling accounts for a notable share of the post-1980 drop in GDP growth, but its role is again less important than that of TFP and capital accumulation. And the jump in TFP growth still explains the entire rise in GDP growth after 1994. The small contributions from labor and physical and human capital reflect, by construction, the low growth in their respective stocks during this period. Indeed this second decomposition confirms that the failed occurrence of factor accumulation, including human capital, has prevented Brazil from resuming pre-1980 GDP growth rates after the Real Plan.

Physical capital accumulation and TFP growth explain most of the growth dynamics of the Brazilian economy since 1930. The higher the value of the capital elasticity of output used for decomposing growth, the higher the contribution of capital and the lower that of TFP. Note, though, that the two need not be dissociated. TFP growth seems to have been systematically associated with the growth in the stock of machinery and equipment, as can be seen by comparing results in Table 4.5 and 4.6. It may therefore be that some TFP growth was gained through capital-embodied technological progress.[8]

[7] Mankiw, Romer, and Weil (1992) actually estimate $\alpha = 0.59$ for middle-income countries when only labor and capital are included in the model, as earlier, and $\alpha = 0.29$ and $\gamma = 0.30$ when human capital is also considered. With the figures in Table 4.3, these values would imply a higher contribution of capital to output growth than estimated with Mankiw's (1995) elasticities.

[8] See De Long and Summers (1991) and Eaton and Kortum (2001) for a discussion of the importance of machinery and equipment investment to growth, particularly when using machinery imported from capital-goods-R&D-intensive countries such as the United States, Germany, and Japan.

Characterizing Growth and Policies in the 20th Century[9]

This section examines how the economy and policy evolved during the last century, focusing on variables that might explain the dynamics of Brazilian output growth. A cursory description of the 1900–30 period sets the stage for a gradually more detailed analysis of the periods that follow.

Oligarchic Orthodoxy, 1901–30.[10] In the first three decades of the 20th century—the acme of the so-called First Republic—Brazilian GDP expanded an average of 4.3 percent per year, or 2 percent per capita, a substantial improvement on earlier growth rates. The period began with a cyclical recovery from the difficult latter years of the 19th century, sparked by a boom in rubber export prices. Aggregate investment reacted with a lag to output performance—partly because almost all capital goods had to be imported—increasing continuously as a ratio of GDP from 4.9 percent in 1901 to 17.8 percent in 1908, dipping slightly in 1909, and rising again from 1910 to 1913, when it peaked at 29.1 percent of GDP (in constant 1980 prices). A substantial part of this investment went to industry and infrastructure: in 1901–14 the rail network expanded 4 percent annually, while total power generation capacity increased 30 times, largely through FDI.

Improvement in the trade and capital accounts led to substantial currency appreciation, with the milreis rising in value from 14.5 cents of a U.S. dollar in 1899 to 25 cents in 1905. To curb further appreciation, a currency board was established in 1906, fixing the exchange rate at 32.3 cents per milreis. Although a brief financial crisis in international markets in 1907 caused a recession in 1907–8, the economy boomed in 1909–12, helped by favorable terms of trade and easy access to external credit, with a particularly good performance by the industrial sector. This rapid industrial growth was facilitated by monetary expansion from the currency board's procyclical

[9] The following overviews are not intended to provide a full historical account of the Brazilian economy in the 20th century. For that, see, among others, Furtado (1971); Fishlow (1972); Prado (1970); Suzigan (1986); Abreu (1990); Lamounier, Carneiro, and Abreu (1994); and Giambiagi and Moreira (1999).

[10] For a description of economic events and policies in this period see Fritsch (1990), on which we partly draw.

incentives, which used monetary policy to reinforce the stimulus provided by the trade account.

The 1913 decline in export prices, together with a surge in imports, caused liquidity to fall, leading to a major deflation and initiating a credit crunch that would last until the beginning of World War I, when the currency board was discontinued. Abandonment of the gold standard was followed by large fiscal imbalances and accelerated inflation, which averaged 17.1 percent annually in 1915–16. However, the government successfully stabilized the economy with the assistance of a loan from foreign creditors, which also helped sustain the exchange rate around US$0.25 per milreis in 1915–18.

GDP remained essentially stagnant during the war, but the industrial sector picked up in 1915–17, after contracting 8.7 percent in 1914. With output capacity enhanced by the capital accumulation in the years preceding the war, firms were able to engage in import substitution, particularly of processed foodstuffs, and to increase nontraditional exports (Fishlow, 1972). The decline in imports cut fiscal revenues and forced the government to expand the basket of products subject to the consumption tax. Combined with low growth in public expenditures, this reduced the public deficit during the war.

Investment levels collapsed with the credit crunch initiated in 1913, falling to 11.7 percent of GDP, and were constrained by the ensuing war, which made importation of capital goods and access to FDI much harder. In 1915–18 the rate of investment averaged a mere 5.7 percent of GDP, with a substantial decline in construction and especially in machinery and capital equipment accumulation, which in this period fell on average to just a seventh of its peak value in 1913. Electric generating capacity and the rail network expanded less than 7.9 percent and 6.3 percent, respectively, from 1914 to 1918.

Brazil's terms of trade dramatically declined during the war, averaging in 1915–18 just 41 percent of their 1914 high. Yet loss of much of the 1918 coffee crop from cold weather and a robust postwar recovery in world economic growth caused Brazilian exports to double from 1918 to 1919, with a 66.5 percent improvement in its terms of trade. Adoption of restrictive monetary policies in the United States and England in 1920 produced a major drop in terms of trade and a decline in exports in 1921, although imports by then had doubled with respect to 1918, reflecting high GDP growth and the partial recovery of investment levels. The impact was severe, as reflected in the 15.3 percent decline in the GDP deflator in 1921, and had an important influence on policy, but this shock proved to be short-lived. Both exports and terms of trade rose in the following years, thanks to a recovery of the world economy and a successful move by Brazil to reduce the supply of coffee in international markets.

After appreciating slightly in 1919, the milreis experienced a major devaluation in 1920–21 and again in 1923, when the exchange rate declined to a U.S. dime per milreis. This depreciation and loose monetary policy stoked inflation to a peak of 30.1 percent in 1923. Currency weakness, high inflation, and the military upheaval of mid-1924 would then convince President Bernardes to adopt an orthodox stabilization program with restrictive monetary *and* fiscal policies, which caused growth to decline to 1.4 percent that year and to zero in 1925, down from an average 8.2 percent in 1922–23. Industrial output, which had expanded at an average of 16 percent per year in 1922–23, showed zero growth in 1924–25.

Despite its high costs with respect to lost output, the stabilization program successfully brought inflation down. As measured by consumer prices in Rio de Janeiro, inflation fell from 16.9 percent in 1924 to 2.7 percent in 1926, and the currency strengthened to US$0.14 per milreis. Contributing to this appreciation was the recovery in Brazil's balance of payments, with the rise in exports and terms of trade referred to earlier and renewed expansion in FDI. Concerned once more with the negative impact of a strong currency on the income of coffee growers and entrepreneurs, the government resorted to a currency board, with the exchange rate fixed at $0.12 per milreis.

The events that followed resembled those of the prewar period. Expansionist monetary and fiscal policies lasted while the balance of payments was favorable but became suddenly contractionary when exports fell, at a time when imports were still growing, thus greatly reducing the trade balance and consequently the money supply. In 1926–28, when the government successfully kept coffee prices high, GDP expanded an average 9.2 percent annually. In 1928 the trade surplus fell to $85 million from $118 million in 1926, just as the supply of foreign credit declined, reducing domestic liquidity. Concerned with the balance of payments, the national government reduced domestic credit, constraining the ability of the government of São Paulo State to finance its coffee price support scheme, particularly in light of the record crops of 1927 and 1929. Coffee prices began to fall in late 1929 and plunged during 1930, further tightening Brazil's monetary policy.

Despite the recessionary effects of the currency board in this unfavorable climate, a decline in industrial GDP, virtual stagnation in the rest of the economy, and a 3.6 percent deflation, the government stuck to the gold standard, hoping the external environment would change. Instead the situation deteriorated further, with a 2.1 percent drop in GDP (–6.7 percent for industrial GDP) and a 12.4 percent decline in the GDP deflator.

The late 1920s illustrate well the volatility during the first third of the century in growth, terms of trade, and exchange rates that could be expected in a primary export economy subject to the vicissitudes of weather and to external shocks, particularly of the magnitude of those registered in 1914–30. These shocks would eventually lead to a shift in economic models and Brazil's form of integration into the world economy, and to the evolution of new urban-based political alliances that overcame the decades-old dominance of agricultural interests, coffee growers in particular.

Although the degree of orthodoxy among Brazilian policymakers in this period is debatable, particularly regarding fiscal and monetary matters, a relative consensus exists that economic policy was predominantly liberal and that state intervention in foreign trade and private activities was minimized except for policies supporting international coffee prices. Governments endeavored to keep inflation low and, indeed, succeeded in doing so by the standards Brazil would set for the rest of the century. Moreover, although import tariffs—measured as the ratio of import taxes to import value—were also at the high-water mark for the century, their purpose was

Table 4.8. Sector Composition of GDP and Employment
(in percent)

	Agriculture		Industry		Services	
	GDP	Labor	GDP	Labor	GDP	Labor
1900[a]	45.0	66.9	13.2	4.2	41.8	28.9
1930[a]	36.3	66.3	17.0	13.6	46.7	20.2
1950	23.2	59.9	25.9	17.6	50.9	22.5
1963	16.2	51.0	34.9	18.8	48.9	30.2
1980	10.1	29.4	40.9	29.1	49.0	41.5
1993[b]	12.5	26.1	39.5	20.8	48.0	53.0
2000[b, c]	12.9	23.6	38.4	19.2	48.7	57.2

Note: GDP composition is based on factor cost, 1980 prices.
[a] Workers in arts and crafts *(artes e ofícios)* and with unidentified occupations are allocated in services.
[b] Uses labor force figures from the new National Accounts System.
[c] Labor figures refer to 1999.

less to promote industrialization than to generate public revenues.[11] The Brazilian economy remained highly concentrated on agriculture, and the industrial share of total output only rose from 13.2 percent in 1900 to 17 percent in 1930 (Table 4.8).

Economic policy would change substantially in the following decades. Fritsch (1990) argues convincingly that this change resulted less from the new political alliances that triumphed in the 1930 revolution than from the shift in the international order and external environment caused by the Great Depression:

> [I]n explaining the profound change in the style of economic policy that takes place from the thirties onwards, in the sense of greater government intervention in international transactions, a more prominent role must be ascribed to the restrictions imposed by the changes in the external environment that prevented the maintenance of the traditional stance. This amounts to minimizing the validity of the notion that, in this change of styles, there was any a priori intention towards increasing incentives to industry, as not rarely is inferred from the assumptions regarding the loss of power of exporters after the collapse of the First Republic.

[11] Indeed, the fact that those revenues were for a long time the main source of public funds also made fiscal policy procyclical, accentuating the volatility in growth.

> The dramatic external disequilibria experienced by Brazil since the late twenties, as a consequence of the collapse in international capital markets, the brutal contraction in international trade and the problems generated by large coffee crops, completely changed the viability of the forms of interaction to the world economy consolidated in the First Republic. Ironically, this created the conditions for overcoming the old problem of how to sustain domestic stability when faced with external shocks without any of the structural or institutional reforms that would have been necessary with the world economy under normal conditions.

Unstructured Import Substitution, 1931–50. This era was a time of relatively high growth marked by a substantial rise in the industry share of output, which rose from 17 percent in 1930 to 25.9 percent in 1950 (Table 4.8). Most of this period was characterized by low import volumes, which were limited either by the attempt to reduce balance-of-payments disequilibria or by World War II supply restrictions. In 1948 imports finally surpassed their real level in 1930, only to dip again in the following year as the government reacted to the trade account by reinstating several controls on foreign exchange expenditures. Overall, imports increased 0.5 percent on average in these two decades, versus 5.1 percent annual GDP growth and 7.3 percent industrial output growth.

Table 4.9. Trade and Current Account Indicators

	Real annual growth of trade (%)		Trade balance	Current account		Parity rate	
	Exports	Imports	GDP	Bal./GDP	Terms of trade	Mean	*SD*
1901–30[a]	2.5	3.0			160.6	42.7	10.1
1931–50	1.5	0.4			118.2	77.1	17.7
1951–63	–1.2	1.7	–0.4	–1.4	164.0	65.8	13.0
1964–80	8.0	5.6	–0.7	–2.4	143.3	86.9	6.0
1981–93	6.5	1.9	3.6	–1.1	94.7	92.6	16.8
1994–2000	4.3	13.5	–0.2	–3.3	124.1	68.4	9.6

Note: Terms of trade are based on 1980 = 100; the parity rate is measured against the U.S. dollar using wholesale price indices.
[a] Years 1908–30 for parity rate.

The process of import substitution in this period was usually a side effect of policies dealing with reduced trade and capital flows during the Depression and World War II and the foreign exchange constraints stemming from Brazil's high foreign debt. Only in the late 1940s did government realize the potential of fostering industrialization through selective protection of specific sectors and a targeted expansion of public credit (Vianna, 1990). As output growth became less closely linked to agriculture and the world market, growth also became more stable, particularly in industry (Table 4.10). As the investment recovery from the rather low rates of the 1930s suggests, this helped foster capital accumulation, with a substantial rise after World War II when trade liberalization and a grossly overvalued exchange rate boosted capital goods imports. A remarkable increase in capital goods investment ensued, with the result that such investment was more than three times higher in 1946–50 than in 1930–45.

Following the difficult years of 1930–31, when GDP declined 2.7 percent annually, the economy recovered robustly in 1932–39, with GDP growing 6.1 percent annually. Compared with the first decades of the cen-

Table 4.10. Average Growth and Annual Variation of GDP, Population, and GDP Per Capita

			Period					
			1901–30	1931–50	1951–63	1964–80	1981–93	1994–2000
GDP	Total	Mean	4.3	5.1	6.9	7.8	1.6	3.1
		Std. dev.	5.1	4.4	2.9	3.3	4.1	2.0
	Agriculture	Mean	3.6	2.7	4.1	4.5	2.4	3.4
		Std. dev.	7.5	5.1	4.0	4.5	5.9	2.6
	Industry	Mean	5.2	7.3	9.5	8.5	0.4	2.6
		Std. dev.	7.0	5.6	4.9	5.3	6.5	3.2
	Services	Mean	4.7	5.5	6.7	7.5	0.5	3.2
		Std. dev.	7.0	5.9	3.9	4.0	5.0	5.0
Population			2.4	2.0	3.0	2.6	1.9	1.4
Per capita GDP			2.0	3.1	3.9	5.1	–0.2	1.7

tury, growth became more inward-oriented and was fueled by expansionist fiscal policies, mainly deficits from massive purchases of coffee that was then burned in order to sustain the international crop price.[12] Monetary policy, which had been clearly contractionary in 1931–32 when prices declined a total of 32.8 percent, also became more expansionary, with inflation averaging 3.4 percent in 1932–39.

The combination of expansionist fiscal, monetary, and credit policies, severe quantitative controls on imports (particularly until 1937, when servicing the foreign debt was a central objective of foreign exchange controls),[13] and the existence of substantial idle capacity from the late 1920s rise in investment provided great stimulus to industry. In 1932–39, industrial output expanded 9 percent yearly, allowing for a decline in the share of imports in domestic supply, in 1939 prices, from 45 percent in 1928 to 25 percent in 1931 and 20 percent in 1939 (Abreu, 1990). Yet because this industrial growth was accomplished essentially by a rise in capacity utilization, the structure of output changed little, with the share of traditional industries (e.g., foodstuffs and textiles) declining a mere 10 percent in 20 years, from 80 percent in 1919 to 70 percent in 1939 (Fishlow, 1972).[14]

The 1930s were marked by controls on foreign exchange purchases, with the severity varying over time. Faced with a 49 percent decline in terms of trade in 1930–32, and with no access to international capital markets, the government suspended foreign debt service and created a foreign exchange monopoly through Banco do Brasil, which received all export revenues. Imports and other foreign exchange expenditures were then allowed

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[12] As noted by Fishlow (1972), though countercyclical fiscal policy might have been unintended, from 1933 onward the deficits were foreseen in the budget. According to Abreu (1990), this willingness to accommodate fiscal shocks with an increase in the fiscal deficit, so different from the usual policy orientation of the First Republic, allows us to "state that the Provisional Government's economic policy was pre-Keynesian."

[13] An interesting development in the late 1930s was the decision to prioritize foreign exchange expenditures with imports, allowing the economy to expand at a reasonable rate at the expense of servicing the foreign debt (Abreu, 1990). Another was the creation in 1940 of the National Steel Plan Commission and the concomitant decision to establish under state ownership Brazil's first large integrated steel producer, Companhia Siderúrgica Nacional, which would begin operations in 1946.

[14] In 1939, domestic output already accounted for the largest part of intermediate goods and consumer nondurables, but this was not true for capital goods and consumer durables (Fishlow, 1972).

according to a list of priorities defined by the government. As in other episodes in 1931–50, devaluation was not deemed worthwhile because of its negative impacts on the international coffee price, inflation, and the fiscal accounts, through government foreign exchange expenditures (in domestic currency). In this sense, the overvalued exchange rate, coupled with the obligation to sell to the government, worked as a tax on coffee and other traditional exports that was passed on to and paid by foreign consumers.

As terms of trade improved in 1934, foreign exchange controls were relaxed some, enabling nontraditional exporters to sell more in the "free" market by mitigating the negative impact on competitiveness of an overvalued exchange rate and allowing importers and foreign investors to buy hard currency. Later, controls would be retightened when liberalization and a decline in terms of trade caused the current account to widen. In different forms the foreign exchange market would remain segmented for many years, with the coexistence of two, three, five, or even ten exchange rates, each applying to a different client, product, purpose, or end of the market. For domestic producers, the virtual ban on competing imports and the access to inputs and capital goods at an overvalued exchange rate provided extreme protection, regardless of the actual nominal import tariffs, which actually declined compared with 1901–30 (Table 4.11). Moreover, the moderate trade opening of the mid-1930s and the privileges ascribed to "essential imports" fueled an increase in the stock of imported capital goods, which increased 27.5 percent between 1934 and 1939.

When World War II began, the economy again suffered a loss of export markets and access to foreign capital, particularly in 1940–42, when

Table 4.11. Average Import Tariffs

	All goods	Non-oil
1901–30	30.4	
1931–50	22.3	25.7
1951–63	9.2	10.9
1964–80	10.8	13.9
1981–93	7.6	11.4
1994–2000	8.7	8.7

GDP grew slowly. In 1942, however, growth resumed as a consequence of expansionary fiscal, monetary, and credit policies and of the stimulus provided by an import substitution drive and an expansion in nontraditional exports made competitive by war conditions. In 1943–45, GDP expanded 6.4 percent annually, with industrial output rising 9.8 percent annually.

However, inflation also rose, not only because of rapid GDP growth but also from lower imports caused by the war. An expansion in the money supply, attributable to monetization of the public deficit (which until 1942 had been financed mainly by increases in public debt), and an increase in the trade surplus (which caused current account surpluses and rising foreign reserves) were contributing factors.

When the war ended and a new government took office in 1946, foreign exchange controls were loosened and the focus of economic policy turned to fighting inflation, which had risen to 20.6 percent in 1944 before falling to 14.9 percent in 1945. The combination of three factors—rising output, an overvalued exchange rate (which had stayed constant in nominal terms since 1939 against an accumulated inflation of 150 percent), and repressed import demand—caused a boom in imports, which almost doubled in real terms from 1946 to 1948. Meanwhile exports—no longer benefiting from wartime conditions but penalized by the exchange rate overvaluation—stagnated. Consequently the trade account went from a US$391 million surplus in 1946 to a US$59 million deficit in 1948.

Trouble signs had already appeared in 1947, however, when the substantial deterioration in terms of trade caused Brazil to record a US$182 million balance-of-payments deficit, which was financed by losses in convertible reserves (US$59 million), accumulation of commercial arrears (US$72 million), and a loan from the Federal Reserve Bank in New York (US$80 million) as noted by Malan et al. (1980). Therefore, foreign exchange controls were reinstated in mid-1947.[15] A new import-licensing system soon brought the trade account back into surplus, abetted by a decline in import prices and a rise in coffee prices.

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[15] Once more the option was not to devalue fully, although there was a small 13 percent depreciation of the (official) exchange rate until 1952.

Industry experienced another boom in the post–World War II years, with average annual growth of 8.1 percent in the late 1940s raising the decade average rate to 7.5 percent annually. Moreover, the industrial structure continued to change, with a 7.5 percent rise in the intermediate goods share of manufacturing output from 1939 to 1949 (Fishlow, 1972) that was offset by a similar decline in the share of traditional industries (consumer nondurables). Yet, just as they had 10 years earlier, the capital- and technology-intensive sectors (capital and durable consumer goods) still accounted for less than 8 percent of total manufacturing output.

Government-Led Import Substitution, 1951–63. The import-licensing schemes and foreign exchange controls implemented in 1931–50 were aimed largely at curbing foreign exchange expenditures, usually to overcome balance-of-payments disequilibria. It was not until the late 1940s, therefore, that the potential of import-licensing schemes as an incentive for industrialization was realized and exploited (Malan et al., 1980; Vianna, 1990). Beginning then, the government began to rely more intensively on tariffs and the sector distribution of import licenses to encourage industrialization through import substitution. Other instruments to foster industrialization that were adopted in the late 1940s included a rise in public credit to manufacturers, access to imports of capital goods and inputs at an overvalued exchange rate, incentives to FDI in manufacturing, and a rise in SOE investment, all of which would intensify in the 1950s.

Although formally in place throughout this period, import-licensing schemes were relaxed in 1951–53 when the Korean War began. Contributing to that stance were an increase in export prices, which produced a major gain in terms of trade and a trade surplus in 1950; concern that the war would cause another shortage of raw materials and capital goods; and an expectation that import liberalization would help curb inflation, which in 1951 had jumped to 18.1 percent from 9.2 percent the previous year (Malan et al., 1980). Not only would imports increase the supply of goods, but a declining trade surplus would reduce upward pressure on the money supply.

The setup echoed that of the trade opening in 1946: high output growth, a grossly overvalued exchange rate (in 1951 the parity rate versus the U.S. dollar was 52 percent of the level recorded 10 years earlier, further appreciating to 40 percent in 1953), and repressed import demand. Unsurprisingly, the result was also the same: an import boom (52 percent real growth in 1951–52) and a substantial worsening of the trade account. In 1952 the current account deficit rose to US$624 million (2.9 percent of GDP), mostly financed through commercial arrears.

Eventually, the government changed courses, tightening import-licensing schemes and introducing a five-tier exchange rate system that penalized traditional exporters (coffee, cotton, and cocoa), nonessential imports, and most profit remittances. This system would later be simplified somewhat, determining the "free" rate in foreign exchange auctions but retaining the underlying principles of the multiple exchange rate system.

A remarkable consequence of the trade opening in 1951–52 was an increase in the rate of investment from 18 percent of GDP in 1949 to 22.1 percent in 1952, when imports of capital goods peaked at twice the average level in 1948–50. The private sector accounted for the entire increase, with its share of total investment rising from 66 percent in 1950 to 78 percent in 1952. This investment boom (boosted by a highly expansionist public credit policy), a 9.1 percent rise in agricultural output in 1952, and an increase in imports (services) largely explain why GDP growth averaged 6.1 percent in 1951–52 despite the priority ascribed by fiscal and monetary policy to price stabilization.

These policy inconsistencies accelerated inflation, which escalated from 9.3 percent in 1952 to 27.1 percent in 1954, the highest level since 1923. A decline in imports that reduced domestic supply and the 216 percent and 100 percent nominal increases in the minimum wage in 1952 and 1954, respectively (Vianna, 1990), were also contributing factors. The economic turbulence was aggravated by power shortages in 1953 caused by a severe drought and the relatively slow expansion of power generation capacity, which had risen by 4.7 percent yearly in 1944–53 while industrial output had grown by 7.9 percent yearly.

The crisis building around President Vargas, culminating in his suicide in August 1954, created a year and a half of political instability. The new government taking office faced not only a politically tense situation but a foreign exchange crisis, sparked by the 49 percent decline in Brazil's 1954 terms of trade, and serious domestic imbalances with a large public deficit and rising inflation. Short-term constraints were eased by new loans from the Federal Reserve Bank in Washington and a syndicate of private banks led by Citibank and Chase Manhattan, while new measures were established to attract FDI (Pinho Neto, 1990).

On the domestic front, the government cut public spending, largely capital expenditures, and tightened monetary and credit policies by raising reserve requirements and curbing lending by Banco do Brasil. The result was a decline in the rate of investment in 1955 and a slowdown in GDP growth from an average 8.3 percent in 1954–55 to 2.9 percent in 1956. A change of finance ministers six months into the new government led, however, to a reversal of several of these measures, including a reduction in reserve requirements and a more expansionary stance by Banco do Brasil. Inflation, which had fallen in 1955, climbed back to 24.5 percent in 1956.

The new government's first year was affected by an agricultural output decline and by stagnation in services, causing GDP to grow a "mere" 2.9 percent despite an 8.6 percent rise in industrial output. Growth would, however, accelerate in following years, as the government embarked on President Kubitschek's Plano de Metas, or Targets Plan, which, launched in late 1956, proposed ambitious and detailed initiatives to foster industrialization and greatly expand infrastructure. It foresaw that by 1960 Brazil would, among other things, expand electricity generation from 3 to 5 million kilowatts; raise oil production from almost zero to 100,000 barrels a day and oil refining capacity from 100,000 to 300,000 barrels a day; pave 5,000 kilometers of roads and build 12,000 kilometers of first-rate highways; double steel output; increase cement production from 2.7 to 5 million tons; raise the output of barilla, nonferrous metals, pulp and paper, rubber, and iron ore for export; and establish a car industry able to produce 170,000 vehicles per year, with a high national content ratio (Abreu, 1990).

The plan was largely successful in attaining its targets. The extension of paved roads more than trebled in 1957–60, while power generation capacity increased by 35 percent, contributing to the major expansion in electricity and transportation infrastructure that marked the 1951–63

Table 4.12. Infrastructure Expansion
(in percent)

	Railways	Electricity	Roads	Paved roads	Telecom
1901–30	2.6	15.6			
1931–50[a]	0.6	4.5	4.6	5.1	
1951–63[b]	–0.3	9.8	5.4	23.9	6.8
1964–80	–1.6	9.8	5.6	16.0	11.2
1981–93	1.0	4.1	0.8	4.9	6.9
1994–2000[c]	–1.5	3.6	0.7	1.7	24.8

[a] Years 1930–52 for roads and 1930–55 for paved roads.
[b] Years 1953–63 for roads and 1956–63 for paved roads.
[c] Years 1994–98 for railways and 1994–99 for roads and paved roads.

period (Table 4.12).[16] Industrialization through import substitution also progressed quickly. Industrial output expanded an average 10.8 percent in 1957–61, pushing its share of GDP to 25 percent in 1961, up from 21.4 percent in 1948. Equally remarkable, by 1959 the share of consumer nondurable goods in value-added manufacturing had declined to 46.6 percent, down from 61.9 percent in 1949, whereas shares of consumer durables and intermediate and capital goods rose from 2.5 percent, 30.4 percent, and 5.2 percent to 5 percent, 37.3 percent, and 11.1 percent, respectively (Fishlow, 1972).

In addition to tariff and nontariff barriers and expanded domestic credit, the main policy instruments used in the Plano de Metas were increased public and SOE investment in infrastructure and basic inputs, and the attraction of FDI into manufacturing just as its weight in the utilities sector was declining. Overall investment averaged 20 percent of GDP, up from 18.3 percent in 1955–56, with the share of public investment rising from 21.6 percent of total capital accumulation in 1950–55 to 25 percent in 1956–60 (the share of SOEs rose from 2.7 percent to 7.4 percent in the same span). The government also successfully attracted FDI, particularly to the auto industry (see Shapiro, 1994). The main instrument, in this case, was Instruction 113, which allowed foreign investment to be made directly

[16] See Table 7.2 in Orenstein and Sochaczewski (1990) for a more complete quantitative assessment of the government's success in implementing the Plano de Metas.

through imports of capital goods. This eliminated the need to bring capital into the country at the overvalued exchange rate and then import capital goods at the "free" market rate. Malan (1984, cited in Abreu, 1990) estimates that 75 percent of FDI and 70 percent of all capital good imports in 1956–60 entered Brazil under the aegis of Instruction 113.

Meanwhile the exchange rate regime continued to operate through a system of multiple rates, some of which were still determined at foreign-exchange auctions. The overvalued exchange rate and the much higher return from inward-oriented investment discouraged exports, which stagnated in this period (and indeed would surpass, in real terms, their 1947 peak only in 1970).[17] In 1957, when ad valorem tariffs were introduced, tariffs were set to produce high effective rates of protection for target sectors, but quantitative restrictions continued to play a central role. One such vehicle was the Law of National Substitution (Lei do Similar Nacional), which had been approved in 1911 but was seldom used until it was dusted off in this period to block imports that competed with "similar" domestically produced goods.

The construction of a new capital city, Brasília, combined with expenditures to shore up coffee prices, rising public and SOE investment, and incentives for industrialization to balloon government spending, generating a deficit that was then largely monetized. In 1957–63, the monetary base rose an average 38.8 percent annually, more than doubling its growth in 1951–56 (18 percent) and triggering higher inflation. From a moderate 7 percent rise in 1957, prices jumped 39.4 percent in 1959, 47.8 percent in 1961, and 79.9 percent in 1963. The worsening macroeconomic climate led to negotiations for an IMF adjustment loan, but talks broke off in 1959 when the Kubitschek government refused to comply with IMF conditions. Negotiations resumed and agreement was reached during the Quadros administration in 1961, but when the president resigned just eight months into his term, new negotiations began that were not successfully concluded until the end of the Goulart administration in March 1964.

[17] Even in current dollars the 1951 peak in exports would not be surpassed until 1968.

In sum, 1951–63 witnessed the first concerted policy effort promoting industrialization and infrastructure development. GDP growth accelerated, particularly in industry, but also in agriculture and services. Growth was inward-oriented, with imports rising 1.7 percent yearly on average, versus a GDP rate four times larger and an annual export drop of 1.2 percent. A considerable rise in investment contributed to this bright performance, increasing to 19.1 percent of GDP in this period from 11.8 percent in 1931–50 (Table 4.13). About half of this investment rate rise was financed by increased savings, while the other half was covered by a decline in the relative price of investment goods due largely to the relatively open stance toward capital good imports and the overvalued exchange rate (Table 4.9).

Favorable trade terms and low import growth prevented major deterioration of the external accounts, despite the decline in exports. Domestic economic fundamentals, however, worsened substantially. The large jump in the public deficit and its financing through monetary mechanisms boosted inflation to a new threshold. On average, the GDP deflator rose 27.1 percent yearly in 1951–63, almost four times higher than 1931–50 and more than fives times higher than 1909–30 (Table 4.14). Inflation became a trait of Brazilian culture.

Table 4.13. Investment Prices and Decomposition

	Gross fixed capital formation/GDP			Investment			National savings		
Period	Current prices	1980 prices	Invest. prices/ GDP deflator	Public	Private	Foreign	Total	Public	Private
1901–30		12.9							
1931–50	11.6	11.8	103.4						
1951–63	15.4	19.1	81.3	3.7	11.7	1.4	14.1	2.5	11.5
1964–80	19.8	21.7	91.2	3.9	15.9	2.4	17.5	3.6	13.9
1981–93	21.2	17.0	125.3	2.9	18.3	1.1	20.0	–7.0	27.0
1994–2000[a]	19.7	16.5	119.3	2.5	17.4	3.3	16.4	–5.4	21.8

[a] For public savings and investment breakdown, averages refer to 1994–99.

Table 4.14. Indicators of Macroeconomic Stability

	Inflation					
	GDP deflator	IGP-DI	*SD* of monthly inflation (IGP-DI)	Black-market premium	Cur. acct. balance/ exports (%)	Foreign debt/ exports
1901–30[a]	5.1					2.2
1931–50	7.4				10.3	2.8
1951–63	27.1	29.9	1.4	64.3	–17.6	1.9
1964–80	40.3	40.1	1.0	14.4	–35.0	2.5
1981–93	695.7	768.4	6.4	46.5	–13.7	3.9
1994–2000[b]	20.1	10.5	0.7	5.4	–44.5	4.1

[a] Years 1909–30 for GDP deflator.
[b] Years 1995–2000 for inflation indicators.

The Brazilian Miracle, 1964–80. In 1963 GDP stagnated, private investment declined, the public deficit reached 50 percent of fiscal revenues, inflation accelerated, and the import substitution process began to show signs of exhaustion. Political instability increased, and in March 1964 a military coup—a looming threat since the early 1950s—overthrew the Goulart government. High inflation rates in the previous two years were partially responsible for the coup's initial popular support.

In power, the military adopted a stabilization program to lower inflation, reduce the public deficit, and correct relative prices. The exchange rate was devalued and a tax reform implemented, greatly reducing tax distortions and raising revenues from 16.3 percent to 22.4 percent of GDP, helping to bring down the public deficit. The stabilization program improved the current account from a deficit of 0.5 percent of GDP in 1963 to a surplus of 1.6 percent of GDP in 1965. Inflation was reined in from 87 percent in 1964 to 24 percent in 1967, aided by a dramatic salary squeeze in which the real minimum wage in Rio de Janeiro, for instance, fell 34 percent between February 1964 and March 1967 (Bacha, 1977).

The new government also implemented significant monetary and capital market reforms, including establishment of a monetary correction (indexation) mechanism that protected investors from "inflation surprises" and was key to restoring confidence in long-term contracts in capital and credit markets. In particular, indexation renewed government's ability to finance its deficit in a noninflationary way (through the sale of public debt securities). Moreover, it allowed the development of mortgage financing, which in coming years would provide a major boost to housing construction. All private and public savings also became protected by indexation.

The government also introduced an indexation mechanism in the foreign exchange market to protect exporters from inflation surprises, establishing a crawling-peg regime with small devaluations at random intervals. This greatly enhanced the stability of real exchange rates, which had fluctuated widely in previous years. Furthermore, in the late 1960s the real exchange rate depreciated further, which combined with a new system of tax exemptions and other incentives to significantly boost manufactured exports.

The contractionary monetary and fiscal policies adopted in this period slowed GDP growth, which nonetheless averaged 3.6 percent in 1964–66, and industrial output, which stagnated in 1964–65. However, with a sharp drop in the relative price of investment goods, the rate of investment reacted positively to the more stable political and economic environment, rising from 16.3 percent of GDP in 1964 to 18.9 percent of GDP in 1966.[18] Also noteworthy was the particularly strong growth in capital goods investment, which more than doubled. Low GDP growth and rising investment combined to create substantial idle capacity: 17.5 percent for the entire economy and 25 percent in manufacturing in 1967.

Economic policy shifted dramatically in later years after a new administration took office, with fiscal, monetary, and particularly credit policies all becoming highly expansionary. A boom in consumer and mortgage credit helped boost the output of durable consumer goods and construction, which were also fueled by the rise in public investment, particularly in infrastructure. In 1968–73, annual investment growth rates in transportation, electricity, and telecommunications averaged 15.1 percent, 13.9 percent, and 44.7 percent, respectively (Ferreira and Malliagros, 1999). This

[18] Computed in 1980 prices.

period would also record a rise in overall capital accumulation, with investment rising from 18.6 percent of GDP in 1967 to 23.6 percent in 1973. Capital goods investment increased an average 17.8 percent per year, with capital good imports rising 24.8 percent per year.

The concession of export incentives, a more stable and competitive exchange rate, and the improvement in the external environment (with high growth in international trade) caused exports to surge, growing by an average 9.7 percent yearly in real terms, with the strongest expansion in manufactured goods, whose share of total exports rose from 28.7 percent in 1967 to 40.6 percent in 1973. Brazil's external position also improved as a result of a 26.7 percent increase in its terms of trade between 1966–68 and 1972–73. Thus the 150 percent real increase in imports was accommodated with only a moderate increase in the current account deficit, which rose from 0.75 percent of GDP in 1967 to 2.01 percent in 1973.

Benefiting from the low initial rate of capacity utilization, and with easy access to European markets softening balance-of-payment constraints, the change in policy orientation accentuated the cyclical recovery of GDP, which expanded an average 11.5 percent annually in 1968–73. Industry led this boom, growing on average 13.2 percent per year, with the output of durable consumer goods expanding 25.4 percent yearly. This surge in growth did not, however, stoke inflation, which fell from 25.5 percent in 1968 to 15.5 percent in 1973 (IGP-DI). The unusual combination of high growth, industrialization, and declining inflation rates caused this period to be dubbed the "Brazilian miracle."

Matters changed rather dramatically, however, when the first oil shock of the 1970s hit. With the price of a barrel of oil jumping from US$2.80 in 1973 to US$11.10 in 1974 and imports of 705,000 barrels per day (as much as 81 percent of its consumption), Brazil was hit hard. The oil shock was not, however, the only problem inherited by the administration that took office in 1974. The final days of the Medici administration had been marked by strong inflationary pressures, stemming from the rapid nonsterilized expansion of foreign reserves (53 percent in 1973 alone) and the maintenance of expansionary policies when output was close to full-employment levels (as illustrated by the 35 percent real expansion in domestic credit in

1973).[19] Rising prices of raw material imports (e.g., wheat, copper, and coal) and of exports added pressure to domestic prices. Furthermore, inflation had been artificially controlled in the early 1970s through price freezes that left a number of key prices misaligned.

Full employment was also pressuring the trade account, which had shown a surplus of $7 million in 1973 after recording deficits of $341 and $244 million in 1971 and 1972, respectively. With the deficit in services also rising, the current account deficit doubled from 1969 to 1970, expanded 133 percent in 1971 and 13.5 percent per year in 1972–73. As noted by Malan and Bonelli (1977), Brazil had been living beyond its means for a number of years and had accumulated rising levels of foreign debt, which increased almost fourfold in 1968–73. That was not the full extent of Brazil's rising vulnerability: "Most important, currency loans, which accounted for only 20 percent of total debt in 1967, represented almost two-thirds (62.4 percent or US$7.85 billion) of total debt by 1973" (Malan and Bonelli, 1977, 24).

The deterioration in the external environment in 1974 went beyond the rise in oil prices. As noted above, other imports on which Brazil was highly dependent, including raw materials and capital goods, also posted substantial price increases. And the industrialized economies that were a primary export market and a source of capital for Brazil slid that year into recession. Repressed inflation and the need for a major structural adjustment in the foreign accounts were legacies of the "miracle" years:

> [T]he balance-of-payments situation during the 1968–73 upswing was not sound: even without the 1974 international oil crisis, Brazil would not have been able to maintain its potential growth rate of GDP because of balance-of-payments disequilibria; when domestic capacity limits and balance-of-payments constraints emerged after 1972, economic policy went into disarray—substituting optimistic propaganda for effective action, Brazilian policymakers let the external debt reach staggering proportions; during the next four years, a rigid import diet will have to be implemented to reduce the net external indebtedness of the country; as a conse-

[19] The volume of credit to the private sector rose from 15.4 percent of GDP in 1966 to 47.9 percent in 1973 and an average 59.8 percent in 1978–79, before declining in following years (Serra, 1980).

> quence, economic growth will have to slow down during a period when significant political changes can be expected to occur. (Bacha, 1977, 47)

The government opted not to follow an "orthodox" stabilization program, choosing instead to sustain the pace of economic growth and make inflation control a secondary priority, leaving the external accounts as the adjustment variable. Indeed the basic features of the government economic program for 1974–79 stressed real GDP growth of 10 percent; a 150 percent increase in exports; accelerated import substitution of capital and intermediate goods; and a large expansion of domestic oil output and infrastructure capital by state enterprises.

This decision to outgrow external imbalances rather than trying to adjust through contractionary fiscal and monetary policies was motivated mainly by two factors. First, policymakers believed that the oil shock would be brief and the external environment would rapidly return to its previous state (Malan and Bonelli, 1977). Second, constraints were imposed by the decision to move ahead with the political transition to which Bacha (1977) alludes. That is, it would have been extremely difficult in a low-growth environment to overpower military hard-liners who opposed the gradual political opening initiated in the mid-1970s, when the hard-line regime of 1968–73 could be touted for its high growth.

In a sense, therefore, economic growth was sought as a source of political legitimacy, not much differently than in the early 1970s. As Lamounier and Moura (1983) indicate, there was a "need to sustain optimism" during a time in which "euphoria with the rates of GDP growth, virtually deified in the Medici period, and even the rhetoric that we would be a great power" were still reverberating in people's minds. Finally, the constituency for growth also included the influential business community, which was not expected to support an orthodox stabilization attempt (as would become evident in the late 1970s when Finance Minister Simonsen attempted one only to be sacked from government). In turn, the substantial liquidity in international capital markets, created by the recycling of petrodollars, provided the means to sustain the previous policy course through the borrowing of large loans at negative (although floating) real rates of interest.

Therefore, unlike most other semi-industrialized countries that adjusted to the negative impact of the first oil shock by expanding exports and reducing output growth, Brazil reacted by expanding import substitution, borrowing more, modestly increasing exports, and accelerating growth (World Bank, 1981; Fundação Getúlio Vargas, 1981).[20] As part of this heterodox response and in an attempt to prevent higher inflation, the government also decided not to let the exchange rate depreciate despite the 29 percent decline in terms of trade in 1974–75. This policy lacked credibility, however, and an import boom ensued as private agents feared either devaluation or an increase in import duties. Imports rose 20 percent in 1974, helping to bring the current account deficit to US$7 billion or 6.3 percent of GDP.

The government reacted by raising import barriers, reversing the modest trade liberalization begun in 1967 (Coes, 1988). Tariffs were raised; surcharges of 30 percent to 100 percent were levied on 40 percent of all goods; prior deposits became mandatory for import licenses; and several other nontariff barriers were used, including a negative import list known as "Annex C" and a more rigorous application of the Law of National Substitution (Pinheiro and Almeida, 1995).[21] These measures put all the burden of adjustment on imports, with real exports remaining virtually stagnant in 1974–77. However, a 55 percent rise in export prices and a 21 percent drop in import quantities were sufficient to generate a trade surplus of US$97 million in 1977, compared to a deficit of US$5 billion in 1974.

But this adjustment had clay feet. In 1978–80 Brazil's current account deficit widened again, reaching US$12.8 billion, or 5.4 percent of GDP in 1980. Contributing causes were a 36 percent decline in terms of trade; a rise in import quantities; and especially a mushrooming external debt, largely contracted at floating interest rates, whose service costs ballooned as Paul Volcker tightened monetary policy in the United States.

Until mid-1980, the government held out, not adjusting to the deterioration in the external environment, trusting that a combination of fur-

[20] For a favorable assessment of this strategy see Cline (1981).

[21] Cline (1981) estimates that tariff protection, including prior deposit requirements, increased by 47.4 percent from 1973 to 1976.

ther import substitution, high growth, and a rollover of foreign debt would suffice to insulate it from external shocks until the situation returned to normal. Thus despite rising inflation and mounting external imbalances, monetary, fiscal, and credit policies remained expansionary, causing GDP to grow 9.3 percent in 1980.

Taken as a whole, 1964–80 was a period of exceptionally high growth. GDP increased an average 7.8 percent annually, with industry expanding 8.5 percent annually. The period also saw relative stability in key macro indicators such as GDP growth, the real exchange rate, and inflation, which was more or less constant despite being higher than in previous decades (Table 4.14). This stability provided an important stimulus to private investment, which in current prices increased from 11.3 percent of GDP in 1970 to 16.8 percent of GDP a decade later. Equally impressive was the investment drive of SOEs, which rose from an average 1.9 percent of GDP in 1961–65 to 7.7 percent of GDP in 1977, before declining to 4.5 percent of GDP in 1980. Consequently infrastructure capital expanded rapidly, sustaining the high growth rates of 1951–63.

The structure of the economy also changed substantially in this period. The share of industry in output and employment rose from 34.9 percent and 18.8 percent in 1963 to 40.9 percent and 29.1 percent in 1980, respectively. In manufacturing, the share of traditional sectors—foodstuffs, beverages, textiles, clothing, tobacco, and wood—declined in value added from 39.4 percent in 1959 to 27 percent in 1980, while the share of more capital- and technology-intensive sectors—machinery, electrical equipment, and transportation equipment—rose from 15 percent to 24.9 percent. Import substitution industrialization peaked during this period, culminating with perhaps the highest ratio of per capita income in Brazil versus the United States in the 20th century.

The Long-Lost Decade, 1981–93. In hindsight, it is clear that policymakers made the wrong choices in both 1974 and 1979–80, clinging to a strategy that had outlived its usefulness. Trying to *grow* out of its external problems, Brazil rapidly amassed large external liabilities, with net foreign debt increasing from US$6.2 billion in 1973 to US$58.4 billion in 1980 and the current account deficit going from US$1.7 billion to US$12.8 billion. Brazil entered the 1980s with its economic fundamentals seriously weakened: inflation was high and rising while the external accounts were exploding. Unable to deal with these twin crises, Brazil entered in 1981–93 a "long decade" of stagnation. In these 13 years, GDP grew on average 1.6 percent yearly versus a yearly demographic expansion of 1.9 percent, resulting in an average annual decline of 0.2 percent in per capita income. Industry was particularly affected, growing a mere 0.4 percent per year.

With the sharp deterioration of Brazil's external accounts in the late 1970s, the government allowed the cruzado to depreciate, and its parity rate against the dollar rose 15.2 percent from 1978 to 1980. When the subsequent rise in inflation caused the currency to appreciate in real terms again in 1981–82 and the current account deficit continued to swell, trade policy was entirely subordinated to macroeconomic objectives. The negative import list (Annex C) was greatly expanded, covering 40 percent of all tradable goods in 1983, while firm import programs and import financing became mandatory. Administrative procedures (e.g., delaying import license concessions) became the main instrument to control imports.[22] On the export side, credit and financial subsidies compensated for the exchange rate appreciation in the early 1980s and compounded the effect of a weaker currency in 1983–85. In 1981–82, firms received incentives worth 74 cents for every dollar of exported manufactured goods (Pinheiro et al., 1993). In 1983 the real exchange (parity) rate was devalued by 25 percent.

GDP declined a total 6.3 percent in 1981–83, which together with the large currency devaluation and the rising import barriers and export incentives produced a major turnaround in Brazil's current account, which averaged a small US$98.5 million deficit in 1984–85. But low growth, the devaluation, and the rise in export subsidies devastated the public accounts. For several reasons—ranging from large public loans contracted in the late 1970s and early 1980s to finance the current account to fear that a devaluation would bankrupt a number of firms with foreign liabilities—much of the exchange rate risk on the foreign debt ended up on public sector books

[22] For a discussion of these policies see Pinheiro and Almeida (1995) and the references therein.

in the early 1980s. This made the external crisis also a fiscal crisis, particularly after the 1983 devaluation, which caused the net public debt, as a ratio of GDP, to jump from 29.5 percent in 1982 to 49.5 percent in 1983 and 53.5 percent in 1984.[23]

With imperfectly indexed fiscal revenues, accelerating inflation caused tax collections to decline from an average 25.4 percent of GDP in the 1970s to 22 percent of GDP in 1985 (the Oliveira-Tanzi effect). Growing public indebtedness caused interest payments to increase just when subsidies were going up, rising from an average 1.7 percent of GDP in 1976–79 to 2.9 percent of GDP in 1980–83. The 1988 Constitution compounded the public finance problem, transferring a sizable share of tax revenues from the federal to state and municipal governments without doing much to redistribute expenditures. Since states and municipalities used the extra revenues to increase their payrolls, the deficit created at the federal level was not compensated by a surplus at the local levels. As a result, the public sector ran very large operational deficits throughout the 1980s, culminating at 7.4 percent of GDP in 1989. The bottom line was a dramatic decline in public savings, which plummeted from +4.7 percent of GDP in the 1970s to –5.8 percent of GDP in the 1980s.

Inflation, which had risen in the late 1970s, spun out of control in 1981–93, averaging an annual increase of 768 percent versus the average annual increase of 40 percent in 1964–80 (IGP-DI). In the 12 months of 1993 prices increased by a factor of 28. Taking the whole 1981–93 period, prices increased 7.7 billion times. In the early 1980s, inflation was fueled by the large public deficit and sparked by the need to achieve a substantial real devaluation. In an economy that for years had been developing sophisticated indexing mechanisms, it soon became clear that once triggered by a change in the exchange rate, inertia would set in and inflation rates would accelerate. The Cruzado Plan in 1986 attempted to counteract inflationary inertia through a price freeze, but the failure to eliminate the high public deficit, the excessive increase in money supply, and the 8 percent decline in

[23] Obviously, part of this jump was merely the accounting effect of the devaluation on GDP measured in dollars.

crop output soon torpedoed the effort. Two other heterodox stabilization plans were attempted during the Sarney administration, in 1987 (Bresser Plan) and 1989 (Summer Plan), but both were short-lived.

Two more attempts took place during the Collor administration. The plan launched in March 1990 was certainly the most traumatic. After a bank holiday, a large share of the economy's financial assets was frozen in the Central Bank, where they would stay for 18 months before being returned in 12 monthly installments. This brutal contraction in money supply caused output to plummet. Policymakers reacted by freeing some assets held at the Central Bank, but again this was done beyond reasonable limits. By the beginning of 1991 inflation was picking up steam again, and another plan was launched, this time resorting to a price freeze. As with the other efforts before it, this too was short-lived.

All five heterodox stabilization plans implemented in 1986–91 included price freezes and changes in established contracts, and as each failed to contain inflation, it fueled uncertainty and further sapped government credibility. In this sense the plans contributed to another key feature of the 1981–93 period: the high volatility in growth, inflation, and the exchange rate.[24] Finally, a change of finance ministers in mid-1991 brought a more orthodox economic team into government that tightened monetary policy, thereby keeping monthly inflation rates at the 20 percent level for several months in a row. As a side effect of the high interest rates in this period, Brazil experienced a large inflow of foreign portfolio investment, causing foreign reserves to more than double from 1991 to 1992 and helping strengthen the currency and curb inflationary pressures.

The bitter cocktail of low and irregular growth, high and accelerating inflation, price freezes, contract breaches by policymakers, and high interest rates could only depress investment. Although in current prices the

[24] The five heterodox stabilization programs of 1986–91 did reduce the public debt as a result of rule changes and contract breaches that caused less-than-perfect indexation of public liabilities, or that imposed lower interest rates on the debt. Together with the currency appreciation in 1986–94, they brought the public debt down to 29.6 percent of GDP by the end of 1994. Creditors, however, sued the government, and since 1995 have been awarded some 5 percent of GDP in compensation known as "skeletons."

investment rate in 1981–93 was 1.4 percent of GDP higher than in 1964–80, in constant 1980 prices it was 4.7 percent of GDP lower. The difference stems from a 37.4 percent rise in the relative price of investment, dating back to 1974 when import barriers to capital goods began to rise, causing capital good imports to fall 81.2 percent between 1974 and 1984. Infrastructure investment also fell during this time, with the transportation network and electricity undergoing falls of 50 percent and 45 percent, respectively, between 1980 and 1993. Thus although growth in the stock of infrastructure capital stayed positive, it showed a remarkable drop-off compared to the prior three decades.

Yet this strategy was quite successful in producing trade surpluses, which in 1984 amounted to US$13.1 billion compared to a trade deficit of US$2.8 billion in 1980. But by the same token, fiscal and credit incentives were a major obstacle to fiscal austerity, which was becoming ever more necessary to curb soaring inflation rates. Concerns were also raised as to whether export competitiveness would outlive the end of government incentives. These policies were clearly unsustainable. Therefore as the foreign exchange constraint lessened, Brazil gradually moved toward a more open and neutral trade policy.

The bright side of the economic record in 1981–93 was Brazil's ability to overcome the external shocks of 1979–81, turning the large current account deficits experienced in 1980–82 into a small surplus in 1984. Adjustment was obtained through a substantial rise in exports, stagnant real import levels, and an improvement in trade terms, particularly after 1986 when oil prices declined considerably. In this period export quantities grew an average 6.5 percent yearly, four times more than output, partially reversing the economy's inward orientation. Imports, in turn, showed a mere 1.9 percent growth rate, slightly more than GDP. All this import growth occurred after 1988, and most after 1990. Indeed, the 1983–88 period recorded a major compression in import quantities, making Brazil a very closed economy.[25]

By the early 1990s, the state's role in the economy had changed dramatically. Trade liberalization, privatization, the end of price controls, a

[25] In 1983–87, non-oil imports were equivalent to just 2.8 percent of GDP.

reduction in entry and exit barriers, enactment of legislation protecting competition, a more open attitude toward foreign investment, and a sharp reduction in red tape in the life of citizens significantly transformed the business environment.

Over a span of several years Brazil progressively reduced protection to domestic producers. Two reforms, in 1988 and 1989, cut the average import tariff from 54.9 percent in 1987 to 29.4 percent in 1989. Most nontariff barriers were eliminated in 1990, with the ban on computer product imports ending in October 1992. Starting in 1990, a preannounced schedule of tariff reductions gradually reduced the average nominal import tariff to 13.5 percent in 1993. In 1994 tariffs were cut further to 10.2 percent as part of the effort to consolidate the Real Plan but were raised again to 13.4 percent in 1997–98 (Kume, Piani, and Souza, 2000). On the export side, trade policy also became more neutral from the mid-1980s onward, especially after 1990. Several subsidies were discontinued in 1983–85, and all were essentially eliminated in 1990. Consequently the value of incentives fell from an average of 3.1 percent of GDP in 1981–84 to 1.3 percent in 1990–91 despite the significant expansion of exports in the meantime (Pinheiro et al., 1993).

In addition to trade liberalization, the government sponsored policies that fostered competition and reduced firms' regulatory burden. The competition law and the antitrust agency were both strengthened, while a number of laws and decrees were revoked, discontinuing public monopolies, entry barriers, and restrictions on certain activities. Regulations on FDI were also eased, which helped boost FDI inflows in the late 1990s.

Privatization also brought a major change in policy orientation in 1981–93. Brazil's first attempt to control expansion of state enterprises dates to 1979, but officially privatization did not begin until 1981 when a presidential decree created the Special Privatization Commission. Over the rest of the decade, the government sold 38 companies, transferred 18 to state governments, merged 10 into other federal institutions, closed 4, and rented 1. Most of the sales were reprivatizations of small companies, and proceeds were minimal (US$723 million) and largely financed from within government. In 1990 the government launched the National Privatization Program, greatly expanding the scope to include large industrial SOEs. In

1991–93, large state holdings in steel, petrochemicals, fertilizers, and other manufacturing sectors were sold to private investors.

Adjustment under the Real Plan, 1994–2000. Notwithstanding the importance of the structural reforms of the early 1990, it was the Real Plan and its success in taming inflation that marked the most important turning point for the Brazilian economy in recent years. The plan evolved in three stages. Phase I was targeted at reducing the public deficit through creation of the Social Emergency Fund, approved by congress in February 1994 to give the executive branch control over 20 percent of previously earmarked budget revenues and either spend or withhold them in 1994–95. Phase II was launched a month later, with creation of the so-called Real Value Unit (URV), a unit of account that was kept at one-to-one parity with the dollar. The URV allowed the alignment of most prices and wages, as well as inflationary expectations, thereby avoiding the carryover of residual inflation into Phase III that had plagued previous stabilization attempts. Finally, on July 1, as most prices and wages had been converted into URVs, currencies were changed, with prices in URVs being quoted in reals. The real became not only a unit of account but also a means of payment. In addition to the careful preparation, the large increase in agricultural output in 1994–96 (which helped to keep food prices down), the appreciation of the exchange rate, and tight monetary policy all contributed to the success of the new currency.

The sudden decline in inflation, from 46.6 percent in June 1994 to 0.6 percent in December, and the currency appreciation caused real incomes and credit supply to rise, leading to a consumption boom that reinforced the cyclical recovery begun in 1993 and spurring a GDP rise of 5.9 percent in 1994. In the first quarter of 1995 the economy was clearly overheated, with GDP expanding 10.7 percent compared to the first quarter of 1994. Growth rates of that magnitude were incompatible with the stabilization effort, not least because the substantial increase in output, largely derived from increasing capacity utilization, did not keep pace with the growth of absorption, moving the trade account from a US$10.8 billion surplus in 1994 to a US$3.3 billion deficit in 1995. Other problems also loomed.

The Mexican crisis of December 1994 inaugurated a series of external shocks that forced Brazilian policymakers to adjust the Real Plan. In March 1995 the government raised interest rates, contracted domestic credit, and devalued the exchange rate, causing GDP to stagnate in the six quarters that followed. Other shocks in 1997 and 1998 were countered in the same fashion, in particular by tightening monetary policy, which caused real interest rates to remain extremely high (an average 23.4 percent in 1994–98).

Fiscal policy, however, took the opposite direction, becoming highly expansionist after 1994. With the decline in inflation, real public spending rose, unveiling a fiscal deficit previously hidden by the acceleration of inflation. Real increases in pensions and civil servant salaries in 1995 and a broadly lax approach toward controlling discretionary spending in 1995–97 were also important. The net result was deterioration of the primary accounts, which went from a surplus of 2.65 percent of GDP in 1993 to a deficit of 0.98 percent of GDP in 1997, before a fiscal adjustment package was adopted after the Asian crisis. Combined with very high interest rates, this deterioration in the primary accounts raised the operational deficit from less than 1 percent of GDP in 1993 to almost 8 percent of GDP in 1998.

Reflecting the booming domestic economy, a strong currency, and the lagging impact of trade liberalization, import quantities soared after the Real Plan, rising 20.4 percent yearly in 1994–98. Export quantities, however, stagnated, increasing at a rate of just 2.3 percent. Thus even though terms of trade increased by 40.6 percent in 1994–96, declining only moderately in the following two years, the external accounts showed a continuous slide, culminating with a US$33.6 billion current account deficit (4.3 percent of GDP) in 1998.

The combination of an expansionary fiscal policy, a strong currency, and tight monetary policy resulted in the rapid accumulation of public and external liabilities, which threatened to gain a life of its own. With the decline in international liquidity that followed the Asian crisis, the government was forced to change the policy mix, introducing gradual measures aimed at weakening the real and reducing the public deficit. The Russian crisis and the continued rise in fiscal and current account deficits forced a more dramatic reform in early 1999, however. In January the real was floated, depreciating significantly, buying time while a more substantial fiscal adjustment program was put in place that generated primary surpluses of 3.3 percent and 3.5 percent of GDP in 1999 and 2000, respectively.

In 1994–98 the government also implemented significant structural reforms, notably the extension of privatization to infrastructure through transfer to private investors of SOEs in telecommunications, electricity, rail transportation, and ports, in addition to highway concessions. A number of constitutional amendments were approved in 1995 to end public monopolies in oil, telecommunications, and gas distribution and reduce discrimination against foreign companies, including the opening of the mining and electricity sectors to foreign investors. With the boom in imports and FDI after 1994, the economy became more open than at any time since the late 1950s.

Growth performance in this period was not particularly remarkable, as noted earlier. GDP growth accelerated only moderately when compared to 1981–93. Moreover, growth volatility, although declining, remained high compared to 1951–80. Output growth was pulled by agriculture, which benefited from trade liberalization, and services, with industry growing less than the rest of the economy. Capital accumulation showed an even weaker recovery than output, with the rate of investment declining in both current and 1980 prices. In this regard, it is important to note that although the relative price of investment goods declined vis-à-vis 1981–93, lower inflation, trade opening, and a strong currency kept the decline below what might have been expected (Table 4.13). The low investment rate translated into a further deterioration of infrastructure, except for telecommunications, which boomed with privatization. Roads and highways remained virtually stagnant, with investment declining as a ratio of GDP, while electricity generation capacity grew only marginally above output. Last but not least, the growth in human capital continued to decelerate from the already low growth rates of 1981–93 (Table 4.3).

Boosted by depreciation of the real, and reflecting the fact that much of the public debt was either foreign or domestic debt indexed to the exchange rate, public liabilities jumped as a proportion of GDP in 1999, closing 2000 at a ratio of 49.3 percent. Thus the public deficit stayed high despite the major effort to increase revenues and cut expenditures. With interest payments on the public debt of 8 percent of GDP, the fiscal deficit closed 2000 at 4.5 percent of GDP. Adjustment in the external accounts was also partial, with only a moderate drop in the current account deficit, which closed 2000 at 4.1 percent of GDP (US$24.6 billion). In this sense, the reforms implemented in the 1990s have been insufficient to overcome the problems inherited from the 1980s or generated in the 1990s. It is no surprise, therefore, that growth has yet to reignite the bright flame of 1951–80.

Explaining Differences in Growth Performance

Summarizing 100 years of economic developments in a chapter is a daring proposition. Anyone familiar with Brazil who has read the previous pages would certainly identify relevant facts or interpretations missing from our summary account. One cannot hope in a handful of pages to do justice to the richness of policy initiatives, the interplay of politics and economics, or the influence foreign constraints on economic policy and growth. The usefulness of our dividing the century into clearly demarcated periods can also be challenged, since outcomes in one period were often the result of policy initiatives or mistakes in previous periods. Different interpretations of the facts and decisions described above also exist. Although further summarizing these 100 years of economic growth in a few regression statistics would seem overtly sacrilegious, the possibilities are too tempting to resist.

This section looks at several variables that may account for differentials in growth rates across the six periods analyzed previously, using a cross-country conditional convergence regression estimated with data extracted from the GDN database (www.worldbank.org/research/growth) for 20 Latin American countries in 1960–99.

Table 4.15 contains the results of our growth regressions. In all cases the dependent variable is the rate of per capita income growth, in constant

Table 4.15. Cross-Country Regressions for Sample Latin American Countries

Variable	OLS 1	OLS 2	TSLS	GMM
Initial income	–0.0406	–0.0349	–0.0206	–0.0349
	(–2.22)	(–1.92)	(–1.24)	(–6.56)
Inflation	–0.0092	–0.0072	–0.0064	–0.0072
	(–2.10)	(–1.73)	(–2.25)	(–7.20)
Investment rate	0.1421	0.0989	0.0558	0.0526
	(2.82)	(1.98)	(1.01)	(3.88)
Black-market premium	–0.0007	–0.0006	–0.0005	–0.0006
	(–1.93)	(–1.97)	(–2.62)	(–9.36)
Terms of trade	0.0131	0.0104	–0.0062	0.0118
	(0.98)	(0.82)	(–0.62)	(3.33)
Trade [(*X* + *M*)/GDP]	–0.0351	–0.0290	–0.0310	–0.0279
	(–3.15)	(–2.71)	(–3.17)	(–9.15)
Secondary enrollment	0.0207	0.0192	0.0243	0.0205
	(1.18)	(1.17)	(1.84)	(5.10)
Life expectancy	0.0513	0.0618	0.0635	0.0830
	(1.00)	(1.23)	(1.38)	(6.02)
World growth	1.1266			
	(3.47)			
Intercept 1960s to 1990s	–7.9798	–2.5877		
	(–2.21)	(–0.89)		
Dummy 1980s		–2.5702		
		(–4.69)		
Dummy 1990s		–2.0661		
		(–3.19)		
Intercept 1960s and 1970s			–0.5754	–3.1904
			(–0.23)	(–3.91)
Intercept 1980s			–3.3872	–5.8385
			(–1.28)	(–6.98)
Intercept 1990s			–2.7651	–5.4437
			(–0.99)	(–6.30)
R^2 (number of observations)				
All	0.52 (72)	0.58 (72)		
1960s			0.25 (14)	0.26 (14)
1970s			0.11 (19)	0.06 (19)
1980s			0.75 (20)	0.72 (20)
1990s			0.33 (19)	0.28 (19)

Note: Growth in per capita GDP is the explanatory variable in all four models.

international prices for each decade (1960s, 1970s, 1980s, and 1990s). Right-column variables include per capita income, measured in PPP prices as a proportion of U.S. per capita GDP, at the beginning of each decade; inflation; the rate of investment; the black-market premium; the gross secondary enrollment rate and life expectancy at the beginning of each decade; total trade ($X + M$) as a percentage of GDP; and average terms of trade in each period, as a ratio of the average terms of trade in 1960–99. The rates of investment in 1960 and the 1960s, 1970s, and 1980s were used as instruments for the rate of investment in the 1960s, 1970s, 1980s, and 1990s, respectively. To capture the effect of difference in the world environment across the four decades, we use the growth rate of world output (PPP prices) in each decade and decadal dummy variables. The regressions are estimated using ordinary least squares (OLS), three-stage least squares (TSLS), and generalized method of moments (GMM) estimators.

The regression results are similar to those of De Gregorio and Lee (Appendix A), with two noteworthy differences. First, trade openness has a negative influence on growth, contrary to De Gregorio and Lee's finding using an alternative definition of openness. Our coefficient suggests that Latin American countries were generally more open in the 1980s and 1990s than in previous decades, and that therefore lower growth did indeed coincide with greater openness. Alternatively greater openness may be picking up the effect of a lower degree of industrial development. Second, we omit institutional variables such as democracy and rule-of-law indices since these factors have varied over time in Latin America and this effect would not be picked up by the GDN databank's fixed country indicators.

Table 4.16 presents average values of the explanatory variables for each period, and Table 4.17 uses our GMM estimators to measure the contribution of each variable to growth performance in each period. The main insight from these results seems to be that while the model predicts fairly accurately the differential in per capita GDP growth between 1931–50, 1950–63 and 1981–93 and 1964–80, it explains much less well the decline in per capita GDP growth in 1994–2000. A possible reason may involve the human capital variables, which suggest an improvement inconsistent with the growth in schooling of the labor force.

Table 4.16. Average Value of Explanatory Variables

Variable	1901–30	1931–50	1951–63	1964–80	1981–93	1994–2000
Per capita income (% U.S., PPP)	17.2	17.1	16.8	19.4	25.7	21.2
Inflation (%)	5.1	7.4	29.9	40.1	768.4	10.5
Investment (% of GDP)	12.9	11.8	19.1	21.7	17.0	16.5
Black-market premium (%)	0		64.3	14.4	46.5	5.4
Terms of trade (1960–2000 = 100)	128.1	94.3	130.8	114.3	75.5	99.0
Trade [(*X*+*M*)/GDP]	19.9	7.5	18.5	13.9	15.6	15.1
Schooling (% secondary enrollment)		2.8	5.8	15.0	33.2	43.2
Life expectancy (years)		39.8	45.9	52.49	62.8	66.9
World growth (PPP)	2.2	1.8	4.5	4.5	2.6	3.4

Table 4.17. Explanatory Variables' Contribution to Growth Differentials (1964–80)

Variable	1901–30	1931–50	1951–63	1981–93	1994–2000
Per capita income	0.08	0.08	0.09	–0.22	–0.06
Inflation	0.25	0.24	0.07	–5.26	0.21
Investment	–0.46	–0.52	–0.14	–0.25	–0.27
Black-market premium	0.01	0.01	–0.03	–0.02	0.01
Terms of trade	0.16	–0.24	0.19	–0.46	–0.18
Trade	–0.17	0.18	–0.13	–0.05	–0.03
Schooling		–0.25	–0.19	0.37	0.58
Life expectancy		–1.05	–0.55	0.85	1.20
World growth	–2.6	–3.0	0.1	–2.1	–1.2
Estimated differential in per capita GDP growth		–1.56	–0.67	–5.03	1.45
Actual differential in per capita GDP growth	–3.46	–2.65	–0.91	–6.15	–4.74

Note: See Table 4.16 for values and definitions of explanatory variables.

Productivity Growth in Brazilian Industry

This section takes a fresh look at the evolution and determinants of total factor productivity (TFP) growth in Brazil's industrial sector during the 1980s and 1990s. The objective is to identify the factors that shaped observed TFP performance. The analysis focuses on four issues: the impact of trade liberalization, the contribution of knowledge embodied in input quality, the role of resource reallocation across firms and sectors, and the factors and constraints shaping investment decisions.

Unlike most previous empirical studies of TFP in Brazil, which use economy- or industry-wide aggregates, this is the first systematic exploration of a large firm-level data set, the Pesquisa Industrial Anual (PIA). A priori, microeconomic data offer two important advantages over aggregate data for studying TFP. First, aggregate TFP patterns may conceal diverging trends among different subsectors and/or types of firms. For example, TFP performance may vary systematically with firm-specific characteristics (e.g., size, composition of input mix), and these relations would be masked in aggregate data. Second, measures of TFP growth based on aggregate data mix firm-level TFP growth with the effects on TFP of reallocation of inputs and outputs across microeconomic units with different productivity levels (through channels such as changing market shares of incumbent firms or entry and exit of firms).[26] Disaggregated data allow one to disentangle the contribution of these two conceptually distinct forces to overall TFP performance.

For Brazil, however, the microeconomic data also pose major challenges concerning their coverage, consistency, and reliability. PIA contains methodological breaks that hamper comparability of data across different time periods and lacks information on the use of productive inputs—even on capital stocks after 1995, and much of its time coverage corresponds to years of extreme inflation, which complicates considerably the construction of variables. While we have made a major effort to correct some of these shortcomings and believe that limiting the extent of measurement error embedded in our TFP estimates has been largely successful, the empirical results reported below should be taken with caution.

This section draws extensively from Muendler (2001a, 2001b), and its analysis proceeds in four stages. First, an overview is provided of select

[26] See Jorgenson (1990) for why this reallocation effect may be particularly important for the short-run evolution of aggregate TFP.

earlier studies of Brazilian productivity growth. The methodological approach to estimation of TFP with firm-level data is then defined, and the main features and problems of the data set are summarized. The patterns revealed by TFP estimates over time and across industrial sectors and geographical regions are then described. Finally, the factors behind observed TFP performance are examined to shed light on the issues under investigation and draw conclusions.

Previous Studies

The evolution of productivity in Brazil has been the focus of a number of empirical studies. Some are concerned with productivity at the aggregate (GDP) level, while others focus on the industrial sector as a whole or on specific subsectors. Among the former group, several studies offer cross-country results, allowing for a comparative perspective on Brazil's productivity performance. Table 4.18 summarizes the results of some recent empirical analyses. Among aggregate-level studies, De Gregorio and Lee (Appendix A) estimated a TFP growth rate for the period 1960–90 of 0.8 percent (below the average in Latin America). When considering the 1980s only, however, they found that the Brazilian economy experienced negative TFP growth of –1.4 percent. In turn, Bonelli and Fonseca (1998) found average TFP growth of 0.1 percent in 1980–89, and 0.2 percent in 1990–97. Using data for a much longer period, Hoffman (2000) estimates a TFP growth rate of 2.6 percent for Brazil in 1950–89. This contrasts with earlier results in Elías (1990), which finds a much lower TFP growth rate (0.8 percent) over a similarly long period, 1940–90. For the 1990s, however, Hoffman finds that TFP growth slowed to 0.1 percent, similar to the results of Bonelli and Fonseca (1998), although with a considerable acceleration to 0.7 percent after 1992.

Finally, two of the most recent studies of aggregate TFP, by Teixeira da Silva (2001) and Gomes (2001), find a similar pattern of fall and recovery despite using different methodologies and data. According to Teixeira da Silva, TFP fell at an annual rate of 0.7 percent over 1980–92, and then rose at an average rate of 0.9 percent in 1993–2000. Moreover, aggregate labor productivity displayed a very similar pattern. In turn, Gomes finds a comparable turnaround in TFP growth—from 0.6 percent to 0.7 percent in 1985–89 to 4.7 percent to 5.7 percent in 1991–98—with the exact figure depending on which method is used.

The studies of TFP in Brazilian industry vary considerably in terms of coverage. Among the earliest studies, Braga and Rossi (1988) used a translog production function to analyze factor productivity for 21 industrial sectors during 1970–83, finding that 10 of the sectors had experienced negative TFP growth.[27] Using a growth accounting method and data from the industrial censuses of 1970, 1975, and 1980, Bonelli (1992) estimated TFP growth in manufacturing in 1975–85 to average 0.8 percent yearly. Only leather, pharmaceuticals, and furniture had negative TFP growth rates in his findings.

The economic reforms of the 1990s renewed interest in TFP manufacturing estimates. Bonelli and Fonseca (1998) estimate TFP growth for aggregate manufacturing and 21 distinct sectors. At the aggregate level, they calculate a negative TFP growth rate of –0.73 percent in the 1980s. For the 1990s, however, they find positive annual TFP growth of 3.4 percent. Similarly Rossi and Ferreira (1999) calculate TFP and labor productivity for 16 industrial sectors in 1985–97, finding that both accelerated for virtually all sectors after 1991. On average, TFP grew at 2.2 percent in 1991–97, compared to an average yearly decline of –2.5 percent in 1985–90. Finally, the study by Gomes (2001) cited above also estimates aggregate industrial TFP accelerating similarly in recent years, with annual TFP growth rising from 0.4 percent in 1976–89 to 3.4–4.4 percent in 1991–98.

How does this performance compare with that of other countries? The development in recent years of several large international data sets has made it possible to compare the growth experience of a substantial number of countries by employing a transparent methodology. A review of these studies is presented in Table 4.18. Elías (1990) presents TFP growth for a group of seven Latin American countries in 1940–90, with Brazil ranking below the Latin America average and below Chile and Mexico. De Gregorio

[27] Another early study is that of Pinheiro (1989), based on firm-level data from the 1970 and 1980 census.

Table 4.18. Recent Studies of Productivity Growth in Brazil

Author(s)	Aggregation level	Period	Yearly TFP growth (%)	Yearly labor productivity growth (%)
Bacha and Bonelli (2003)	GDP	1940–2000	0.32	
		1970–80	0.09	
		1980–91	–2.28	
		1991–2000	1.73	
	Industry (excluding construction)	1950–99		3.38
		1980–91		0.47
		1991–99		4.80
Bonelli and Fonseca (1998)	GDP	1980–89	0.10	
		1990–97	0.20	
	Transformation industries	1980–89	–0.73	
		1990–97	3.38	
	General industry	1992–97		9.59
	Textiles			6.20
	Nonmetallic mineral products			11.46
De Gregorio and Lee (Appendix A)	GDP	1960–90	0.80	
		1980–89	–1.40	
Elías (1990)	GDP	1940–90	0.80	
Gomes (2001)	GDP	1975–98		0.21–0.30
		1975–89	0.56	0.12–0.14
	Industry	1990–98	3.20–4.07	0.39–0.46
Hoffman (2000)	GDP	1950–89	2.60	3.90
		1990–98	0.10	0.40
		1992–98	0.70	1.00
	Industry	1976–89	0.37	
		1986–98	0.78–1.37	
		1976–98		3.76
		1986–98		3.5–4.7

and Lee (Appendix A) examine TFP growth for a larger sample of 21 Latin American countries during a shorter time span, 1960–90, finding that Brazil exceeds the Latin American average.

Latin American TFP grew 1.9 percent yearly in the 1960s and 0.7 percent in the 1970s, while declining 2 percent annually in the 1980s. Brazil's

TFP growth rates in the 1960s, 1970s, and 1980s were 1.5, 2.5, and –1.4 percent, respectively. In summary, Brazil's TFP growth (decline) was above (below) Latin America's TFP growth (decline) in the three decades covered by De Gregorio and Lee except for the 1960–69 period. Brazil's 1970s TFP growth was almost three times the Latin American average.

Finally, Nehru and Dhareshwar (1994), using a sample of 83 industrial and developing countries for the period 1960–87, obtain annual average TFP growth for Brazil, Chile, and Mexico of 1.39, 0.37, and 0.68 percent, respectively. These figures are higher than the ones observed in Elías (1990) and De Gregorio and Lee with smaller samples of countries. Moreover, Brazil's TFP growth is higher than the averages for the OECD countries and Latin America during the same period.

It is interesting to compare the performance of *industrial* TFP in Brazil with that in other countries. Jorgenson and Stiroh (2000) report TFP growth for 37 industries in the United States, using a growth accounting methodology for the period 1958–96. Industry-wide TFP grew 0.48 percent yearly, but individual growth rates ranged from 1.97 percent in electronics and electrical equipment to –0.44 percent in printing and publishing. Nine industries had negative productivity growth for nearly 40 years.

Liang and Jorgenson (1999) use a translog production function to estimate industry TFP growth for Taiwan in 1961–93. TFP growth of the manufacturing sector rose from 0.2 percent yearly in 1961–82 to 0.55 percent in 1982–93, and to 0.32 percent for the whole period. In 1961–82, the highest TFP growth was in electrical machinery and electronics (5.44 percent per year) followed by textiles and food. Lagging behind were wood and furniture products with a rate of –12.35 percent and paper and printing with –8.66 percent.

For Latin America, the World Bank (1999) details TFP growth for manufacturing in Mexico in 1993–97. Between 1993 and 1995, TFP growth accelerated from 0.6 percent to 13.8 percent annually. TFP growth rates subsequently fell to 1.3 percent in 1995–96 and to –3.9 percent in 1996–97. TFP growth estimated at the two-digit industry level shows two groups. The first group—food, textiles and apparel, wood products and furniture, and clay and cement products—has TFP growth below the industrial aver-

Table 4.19. International Studies of TFP Growth

Author(s)	Aggregation level	Period	Yearly TFP growth (%)
Collins and Bosworth (1996)	GDP		
	Latin America	1960–94	0.2
	East Asia		1.1
	Taiwan		2.0
	Korea		1.5
	United States		0.3
De Gregorio and Lee	GDP		
(Appendix A)	Latin America	1960–90	0.1
	Argentina		–0.5
	Brazil		0.8
	Chile		0.9
	Mexico		0.5
	Latin America	1960–69	1.9
	Argentina		0.7
	Brazil		1.5
	Chile		1.6
	Mexico		2.3
	Latin America	1970–79	0.7
	Argentina		0.6
	Brazil		2.5
	Chile		0.5
	Mexico		1.2
	Latin America	1980–89	–2.0
	Argentina		–2.6
	Brazil		–1.4
	Chile		0.6
	Mexico		–1.8
Elías (1990)	GDP		
	Latin America	1940–90	1.2
	Argentina		0.5
	Chile		1.4
	Colombia		0.8
	Mexico		1.1
Nehru and Dhareshwar (1994)	GDP		
	Latin America	1960–87	0.13
	Brazil		1.39
	Chile		0.37
	Mexico		0.68
	OECD		0.76

age. The second group—paper and printing, chemicals, metals, machinery and other industries—has above-average TFP growth rates.

On the whole, the international evidence suggests three things. First, Brazil in recent decades has lagged behind East Asian economies in productivity growth but has been roughly on par with the rest of Latin America. Second, TFP in Brazil, as in other developing economies, accelerated in the 1990s after a disappointing performance during the 1980s. Finally, industrial TFP growth in Brazil, as in other countries, whether developed or developing, varies widely across sectors; and negative TFP growth rates at the sector level are often encountered in the literature.

Several studies on Brazil offer hypotheses to explain this time path of TFP—and a few actually test some of them. We should note that one likely reason behind the 1990s recovery of TFP in Brazil (and other Latin American economies) is the procyclicality of productivity estimates, which tend to follow the regional pattern of recession in the 1980s and recovery in the 1990s.

This is particularly clear from the annual TFP growth figures underlying the period-average TFP growth rates in Brazil to which we have referred thus far. These figures display large swings from year to year, tracking closely the economy's annual growth performance. For example, most estimates show abrupt TFP declines in the severe recessions of 1983 and especially 1990 (Teixeira da Silva, 2001; Gomes, 2001; Bonelli and Fonseca, 1998).[28] Indeed, estimated TFP growth is strongly correlated with the growth rate of the corresponding value-added aggregate, whether at the economy-wide level (GDP) or the industrial level (industrial GDP). For example, Gomes (2001) reports that the correlation between his estimates of aggregate TFP growth and observed GDP growth is in the range 0.72–0.76, while for industrial TFP the correlation is even higher, 0.86–0.88. This procyclicality partly reflects measurement error regarding labor and capital utilization, for which no good proxies exist in the Brazilian case, as well as the methodological failure of existing studies to account for the possible impact of economies of scale when estimating TFP.

[28] For this reason, Gomes (2001) excludes the year 1990 when computing period averages of TFP growth.

But other factors are also at play behind this dynamic pattern. First, the decline in macroeconomic instability in the 1990s relative to the preceding decade, particularly as reflected in the post-1994 containment of inflation, likely played a key role in TFP recovery by facilitating investment decisions and restoring the informational value of relative prices to guide resource allocation (Teixeira da Silva, 2001; McKinsey, 1998). Second, several studies have credited the structural reforms of the 1990s, which strengthened the role of domestic and foreign competition, with having had an impact on TFP (Hay, 1997; McKinsey, 1998; Rossi and Ferreira, 1999; Gomes 2001). The decline in public infrastructure investment as part of the fiscal crunch of the 1980s and the constraining action of labor regulations on firms' ability to shed labor (and hence their willingness to employ it) are also among the explanations that have been offered for the productivity slowdown of the 1980s. These are explored in some detail in McKinsey (1988), which concludes that they did not play a major role in the observed time path of TFP in Brazil. We revisit these issues below.

Estimation Technique

The analytical approach underlying our TFP estimations is described in detail in Muendler (2001a). The approach is based on the estimation of sector-specific Cobb-Douglas production functions relating output to capital, intermediate materials, and skilled and unskilled labor:

$$y_{it} = \beta_k k_{it} + \beta_{bl} l_{it}^{bl} + \beta_{wh} l_{it}^{wh} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it}. \qquad (4.5)$$

Here y denotes real output, k is capital, m represents materials, and l is labor input, with the superindices *bl* and *wh* respectively denoting unskilled and skilled labor (or more precisely, blue- and white-collar labor). All variables are expressed in logs, and the subscripts i and t refer to the firm and period, respectively. (Log) TFP is measured by the composite error term, which consists of a serially correlated productivity index ω observed by the firm, and an unobservable random technology shock ε.

Estimation of (4.5) using firm-level data poses two well-known problems. First, firms choose their inputs on the basis of the observed productivity index ω, which renders the right-side variables endogenous and requires an instrumental variable procedure for consistent estimation of the βs. Second, since firms' entry and exit decisions will likewise depend on their productivity level, at any given time the available sample of firms suffers from selection bias due to the exit of the least productive firms and the entry or survival of the most productive ones. The estimation procedure adopted here follows Olley and Pakes (1996) and is designed to overcome the simultaneity and selection problems when estimating production functions.

In this manner, we can recover from estimation of (4.5) the firm-level values of TFP and hence its growth rate. To arrive at sector- or industry-wide TFP growth estimates, which often are of direct interest, it is important to note that aggregate TFP change between two periods can be decomposed into four ingredients:[29] the TFP growth of incumbent firms, given their size (i.e., given their respective shares in total output); the change in size of incumbent firms, given their respective TFP levels; the TFP level of new entrants; and the TFP level of exiting firms.

To assess the factors behind observed TFP performance, we rely mainly on a regression framework relating TFP, as estimated from (4.5), to a set of explanatory variables that summarize firm and sector characteristics. The basic specification is of the form

$$\omega_{it} = x_{it}\delta + \alpha_i + u_{it}, \tag{4.6}$$

where x is a vector of explanatory variables; δ represents the parameters to be estimated; α is a firm-specific, time-invariant effect; and u is a random disturbance. In the experiments reported below, parameter estimates for equation (4.6) were obtained using fixed-effects regressions, since Hausman tests rejected the random effects specification.

In addition to (4.6), we also estimated specifications, with the dependent variable in first differences, to assess the effects of different factors

[29] The decomposition we use follows along the lines of Baily, Hulten, and Campbell (1992).

on TFP growth. In these equations the explanatory variables were lagged one period since the objective was to examine the role of firm and sector features on subsequent TFP growth performance. For both the level and difference regressions we checked for residual autocorrelation, using the technique Baltagi and Wu (1999) devised to control for time gaps in the sample (e.g., the unavailability of PIA in 1991) in unbalanced panels. In general, we found no evidence of serial correlation.

Data

Our source of firm-level data is the PIA, an annual survey of manufacturing firms[30] administered by the Brazilian census bureau since 1986, and available until 1998 (with the exception of 1991, when no survey was conducted). The survey is biased towards medium-sized and large firms, and thus cannot be viewed as representative of the entire manufacturing sector, which includes numerous small firms. Muendler (2001b) has described the PIA in detail, so discussion here is limited to a few key issues.

First is the question of the sample. The sampling method, and thus the sample's correlation to the universe of larger industrial firms, has changed over time. When the survey was launched, it included all the largest manufacturing firms, plus a random sample of medium-sized ones and a nonrandom selection of (large) new entrants. Over the years, all surviving originally surveyed firms remained in the sample, while new entrants were not added after 1993. The exit of old firms and absence of new ones has reduced the sample's representativeness. Furthermore, in 1996 almost a third of the original sample was dropped from PIA records due to a change in sampling method. Consequently, the data before and after 1995 are not strictly comparable.

Second is the question of measurement. PIA contains income-statement and balance-sheet data, plus information on a few economic vari-

[30] PIA also contains plant-level data, although they are much less comprehensive than the firm-level data used here.

ables, including number of workers and investment flows. These data pose measurement problems for TFP estimation.

Only the number of workers (by white and blue collar) is available, not hours worked. No information is available on capital-stock utilization, a common problem with firm-level data. As a result, standard estimation procedures such as ours will incorrectly identify as TFP changes any output fluctuations derived from varying use of labor (and capital) inputs. Since hours worked are procyclical, our TFP estimates also will tend to behave procyclically, although this seems to be less problematic with our data than in earlier studies.[31]

Brazil's high inflation during the period of analysis introduces other difficulties for the calculation of real output and intermediate input series. These series must be constructed from income statements, which are reported in nominal terms. Hence the task requires price deflators for outputs and intermediate inputs. In the absence of firm-level price data, it is customary to use sector-level price indices. In our case, the measurement error generated by the use of approximate deflators is likely to be magnified by the relative price volatility that usually accompanies extreme inflation,[32] as well as by the fluctuation in output sales, input purchases, and inflation over the year. Considerable effort was devoted to the construction of adequate sector-specific price indices for input purchases, and a number of alternative deflators were considered for output.[33]

Construction of the capital stock poses similar difficulties. Up to 1994, our capital stock figures are based mainly on balance-sheet data (which typically include an adjustment for inflation based on government-mandated price indices that tended to understate actual inflation). The situation is more complicated after 1995 because PIA ceases to include balance-sheet data, and capital-stock figures for later years must be constructed on the basis of investment flows. As with value added, consider-

[31] There are reasons other than measurement error why productivity should be procyclical (Basu and Fernald, 2000). But in our data, these reasons are very likely of secondary importance.

[32] For the Brazilian case, see Fava and Cyrillo (1999).

[33] The results reported here make use of the sectoral WPI. See Muendler (2001b) for extensive details on the efforts made to construct appropriate deflators for output, intermediate inputs, and capital.

able efforts were made to arrive at suitable deflators for investment and the capital stock, yet measurement error is still likely to remain in the constructed capital stock series.

In summary, these measurement problems[34] imply that the TFP estimates reported below should be interpreted with caution. Still, it is also worth noting that in the context of regressions such as (4.6) much of the measurement problem error is likely to wash out. Measurement error in the dependent variable should not affect the consistency of parameter estimates when the measurement error is uncorrelated with the right-side variables. If this latter condition is met, the inferences drawn from estimation of equations like (4.6) about the determinants of TFP should remain valid even if TFP itself is measured with error.

Finally, one must consider questions of sample selection and aggregation. Firms in the sample were grouped into sectors according to their two-digit-level industrial classification—the so-called Nível 50 classification—which comprises a total of 27 industrial sectors accounting for roughly two-thirds of total industrial value added in the late 1990s.[35] For most of the empirical analysis, however, only 13 sectors possessing the largest number of firm-year observations were retained.[36] In the late 1990s, these 13 sectors accounted for about half of the value added by Nível 50 industry, or about one-third of the value added in overall industry (Figure 4.1). Equation (4.5) was separately estimated for each of these 13 sectors.

Pattern of TFP Growth

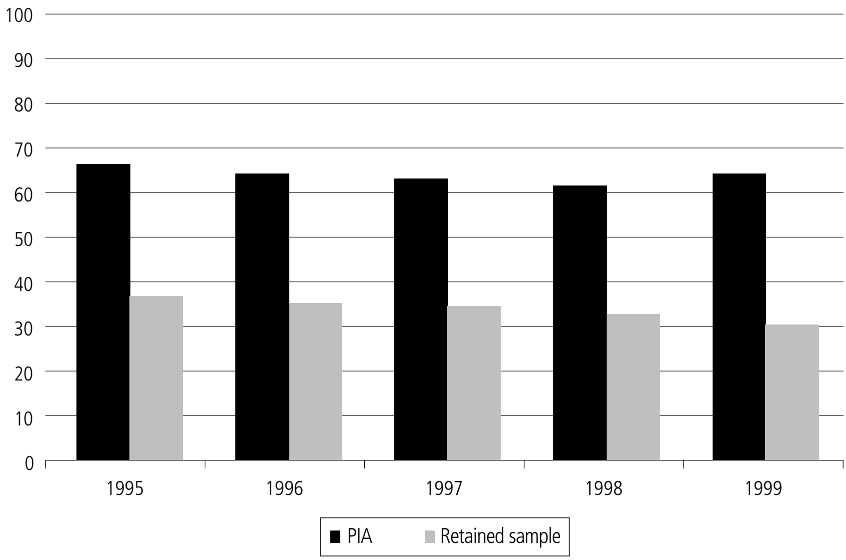
Figure 4.2 plots the estimated log TFP series for all Nível 50 industry, as well as that corresponding to the 13 sectors under consideration. In addi-

[34] Like many other firm-level studies, we lack information on input quality—other than the crude distinction between blue- and white-collar workers. One should keep in mind that changing input quality has been shown to be a major factor behind TFP growth; see Jorgenson (1990) and Gu and Ho (2000) for some illustrative figures about the United States and Canada.

[35] The Nível 50 excludes five sectors included in overall industry: minerals, oil and gas, other industries, utilities, and construction. The latter is by far the largest, accounting for nearly 10 percent of GDP.

[36] The threshold for inclusion was at least 2,500 firms.

Figure 4.1. Industrial Aggregates
(percentage of total industrial value added)

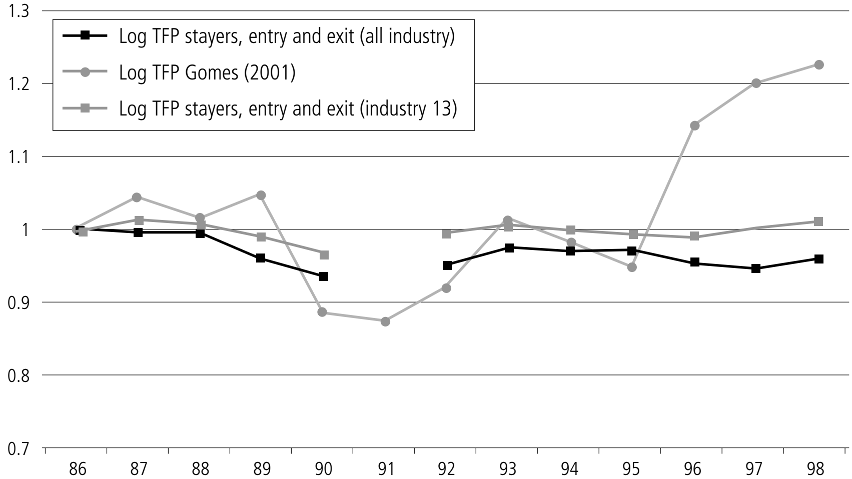


tion, for comparison the figure presents the industry-wide log TFP series estimated by Gomes (2001) on the basis of data from the Pesquisa Industrial Mensal (PIM).[37] For comparability, all three series are rebased to equal 1 in 1986.

The time pattern of our firm-level data estimates of TFP is qualitatively similar to that found by most of the studies summarized in the previous section. TFP experiences a declining trend in the late 1980s and then recovers in the 1990s. However, the amplitude of this cycle is very small, and on the whole the figure suggests that Brazil's industry-wide TFP has shown little change over the period of analysis. This conclusion is further strengthened if 1990 is ignored as an anomaly in which the severe recession accompanying the Collor Plan produced a largely artificial collapse of measured TFP due to the sharp decline in labor and capital use.

[37] Unlike PIA, in which the unit of observation is the firm, PIM is based on production-line data. Gomes (2001), however, is based on aggregated PIM information rather than the raw data. While PIM's sample size is smaller than PIA's, it contains information on hours worked, allowing utilization to be considered in the analysis.

Figure 4.2. Industry-Wide TFP (1986–98)

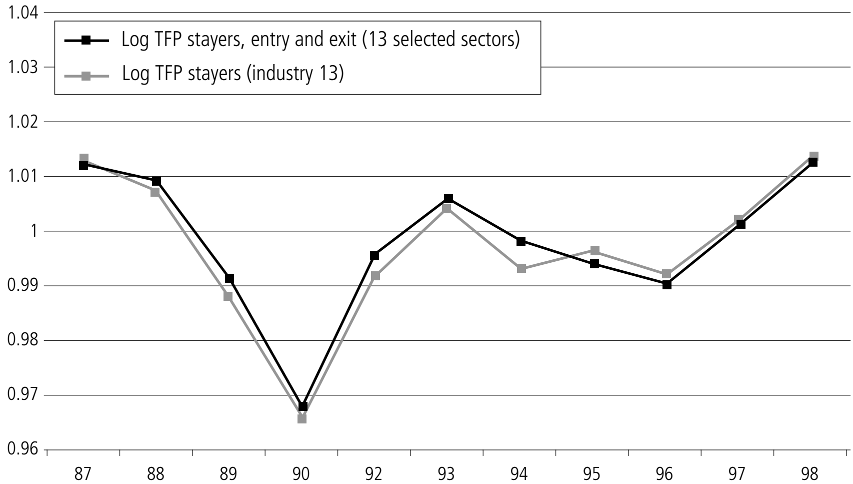


As Figure 4.2 also shows, until 1995 the PIA-based TFP estimates display a time pattern similar to that of Gomes's (2001) PIM-based estimates, but the volatility of the former is much smaller than that of the latter. This suggests that the PIA-based estimates may be less subject to measurement error and hence display less procyclicality than the estimates obtained by Gomes. After 1995, however, the two sources yield divergent TFP estimates, with those of Gomes showing a steep rise absent from the estimates obtained here.

As noted earlier, aggregate TFP growth reflects resource reallocation across firms in the form of exit by old firms, entry by new ones, and productivity changes in the holdovers (with this latter component in turn including both productivity changes at the firm level and changes in the relative size of holdover firms).[38] Using PIA enables one to separate the effects of entry and exit from the change in the TFP of the holdover group. Decomposition results are displayed in Figure 4.3, which compares the

[38] The importance of these reallocation effects for aggregate measures of TFP has been amply documented, for example, by Jorgenson (1990) at the macroeconomic level and by Olley and Pakes (1996) at the firm level.

Figure 4.3. Industry-Wide TFP, 13 Sectors, All Firms and Stayers (1986–98)



time path of aggregate TFP for the 13 sectors of analysis with the path that results from ignoring entrants and exiters. The two series move closely in tandem; the biggest gap arises in 1994, but its magnitude is negligible. This is essentially a reflection of entry's limited role in the PIA sample.

In sum, our estimates agree with previous results showing a TFP recovery in the 1990s, but disagree in showing much less TFP variation over time than earlier estimates. Table 4.20 condenses the information in Figure 4.3 into the average TFP growth rate over the 1980s and 1990s in the PIA data; for comparison the figures from Gomes (2001) are also presented.

Table 4.20. Industry-Wide Annual TFP Growth Rates (1987–98)

	Thirteen Selected Sectors	All Industry (Nível 50)	Gomes (2001)
1987–89	–0.29	–1.30	1.67
1987–90	–0.81	–1.62	–2.49
1991–98	0.29	0.19	5.99
1987–98	0.10	–0.33	2.12

In the 1980s, TFP declined at an annual rate of 0.8 percent (0.3 if 1990 is ignored) for the 13 sectors of analysis, and 1.6 percent for overall industry (1.3 without 1990). In the 1990s, however, TFP grew at positive, albeit modest, rates, 0.3 percent per year for the combined 13 industrial sectors on which we focus and 0.2 percent for overall industry.

As mentioned earlier, the evolution of holdover firms' aggregate productivity reflects two forces: the time path of firm-level TFP and the changes in firms' relative size. It is useful to examine the contributions of both factors. Figure 4.4 shows the decomposition, delineating the contribution firm-level TFP and changing firm and sector size make to TFP growth each year. It is apparent that changes in firm size actually *detracted* from aggregate productivity in most years, with 1992 and 1996 being the lone exceptions, while changing sector size had a more mixed impact on observed TFP growth. This suggests that resource reallocation proceeded in a way harmful to aggregate productivity, an issue that will be more fully examined later in the chapter.

Figure 4.4. Decomposition of TFP Growth among Stayers (1987–98)

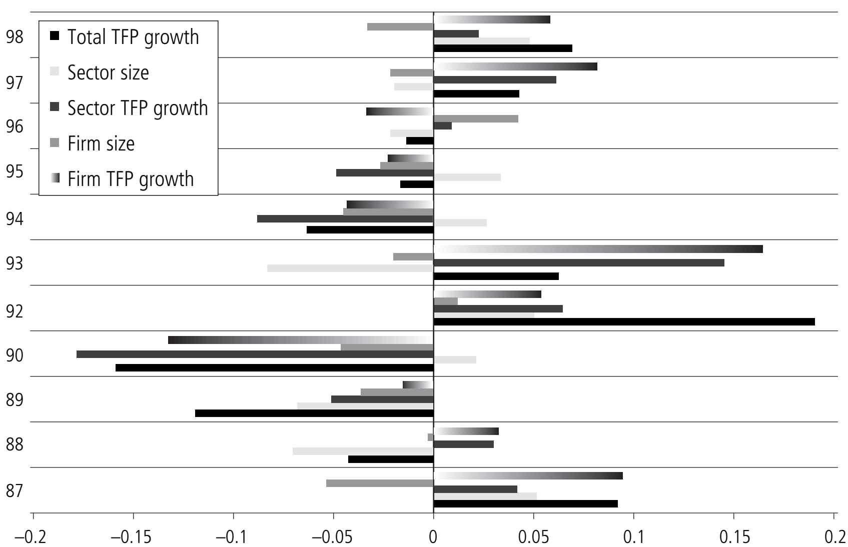


Table 4.21. TFP Growth by Sector
(in percent)

	1987–90	1991–98	1987–98
Nonmetallic mineral products	–7.77	–1.16	–3.56
Other metallic products	1.17	1.15	1.16
Manufacturing and maintenance of machinery	–5.42	3.06	–0.02
Electrical equipment	–3.32	12.07	6.48
Wood and furniture	–12.94	0.43	–4.43
Paper, pulp, and cardboard	–0.02	2.83	1.80
Plastics	–5.76	0.14	–2.01
Textiles	–1.25	–2.06	–1.77
Apparel	–16.73	6.05	–2.23
Leather products and footwear	–0.79	–2.34	–1.78
Processed and edible products	–7.31	0.03	–2.64
Food and beverages	–3.06	–4.10	–3.72
Vehicles and parts	–3.34	6.95	3.21

The cross-sector patterns of TFP growth underlying these aggregate figures from PIA are summarized in Table 4.21. Only average TFP growth rates over the same subperiods as in the preceding table are reported, and the figures include only the group of holdover firms for the 13 sectors under consideration. The period to 1990 was characterized by a TFP slump in virtually all sectors except for other metallic products, which exhibited positive TFP growth during the late 1980s. The worst performances came in apparel and in wood and furniture, for which the estimated TFP decline is very large. Again, exclusion of 1990 would considerably reduce the size of some of these seeming declines, but would not reverse them. In the 1990s, by contrast, nine out of thirteen sectors experienced positive TFP growth, with especially high rates in electrical equipment and in vehicles and parts. Four sectors continued to experience a TFP slump in the 1990s: food, textiles, leather, and nonmetallic minerals.

This pattern is broadly similar to Rossi and Ferreira (1999), who used aggregate PIA data. They also report a uniform TFP decline in 1985–90, followed by a uniform increase in 1991–97. Furthermore, the vehicles and parts sector is also the recent performance leader in their results, with electrical equipment among the top performers as well.[39] The rapid productivity gains by the vehicles and parts sector in the 1990s are also documented in McKinsey (1998), which traces them to the trade opening during the decade.

Finally, we examine TFP growth patterns from a regional perspective. For this purpose, the country is divided into three geographical regions: São Paulo, the South plus the rest of the Southeast, and the North and Northeast. It is important to note from the outset that these regions differ considerably in the size of their industrial sectors. In 1997, São Paulo provided 44 percent of Brazil's industrial value added. Including the South and the rest of the Southeast, the figure rises to 85 percent. The North and Northeast account for the remaining 15 percent. Furthermore, the three regions differ considerably in their industrial composition. Since not all sectors are significantly represented in every region, we focus on industry aggregates. Until 1990, the profile is fairly homogeneous across regions: all experience falling TFP. In the 1990s, however, a large gap opens between the Northeast, which witnesses a further abrupt decline in TFP in 1994–95, and the other two regions, which show rising TFP, especially rapid in the South and remaining Southeast. This contrasting regional performance likely reflects the Northeast's limited share of the industrial sectors that led TFP performance in the 1990s (such as cars and parts, and electrical equipment).[40]

Policy, Structural Factors, and TFP Growth

We next study the policy and structural factors shaping TFP performance, using TFP estimates constructed above. The ultimate objective is to assess

[39] Rossi and Ferreira also found rapid TFP gains during 1991–97 in the chemical sector, which is not included in our analysis. We should note, however, that our sectoral TFP performance rankings are fairly different from those of Gomes (2001), who uses national accounts data on industrial value added by sector. He reports negative TFP growth in 1990–98 in 8 of our 13 sectors, perhaps because he includes 1990 in the period of analysis. In that year most sectors display a TFP decline, which, as mentioned earlier, basically reflects the deep recession that took place. Nevertheless Gomes also finds that the automobile sector was at the top in terms of TFP growth in the 1990s.

[40] Indeed, if we perform the same exercise but include all industrial sectors—rather than the 13 in the text—the estimated TFP performance of the Northeast compares much more favorably with that of other regions.

how selected aspects of the policy and regulatory framework have affected the evolution of Brazilian industrial firms over the last decade. Specifically, the focus is on four broad sets of questions:

- *Trade Barriers*. How has the changing exposure to foreign competition affected firm productivity? Did the decline in protection during the 1990s spur TFP improvements?
- *Knowledge*. What role has the knowledge that is embodied in physical and human capital played in promoting firm productivity? Has the latter been improved by the availability and use of foreign equipment (which may embody the latest technology available in world markets), by information technology, and by human capital?
- *Resource Allocation*. How do firm size and TFP interrelate? Do newer firms bring in higher-productivity techniques? Does greater capital intensity of production cause higher or lower TFP? Did the regulatory environment reallocate resources toward the most productive firms? How did the rules and regulations constraining labor adjustment affect firm performance? Did they pose a significant burden to firms seeking to downsize operations?
- *Physical Capital and Investment*. Was insufficient investment an obstacle to productivity improvement? What factors constrained firms' ability to expand their capital stocks?

To address these issues, we rely mainly on results from the multivariate regressions introduced earlier in the chapter. To avoid omitted-variables bias, explanatory variables that attempt to capture the various factors affecting TFP are included. Thus to reflect the changing exposure of domestic producers to foreign competition, we include in the regressions the value-added-weighted nominal tariff rates by sector constructed by Kume, Piani, and Souza (2000); the real exchange rate; the sector-specific degree of local market penetration by foreign exporters (defined as the ratio of imports over total final uses for each sector's goods, based on Ramos and Zonnenschain, 2000); and the firm-specific ratio of exports to total sales. Next, in regard to the impact of embodied knowledge, we examine how the composition of capital and labor inputs affects TFP. For capital, we focus on the ratios of used machinery to all machinery and of imported machinery to all machinery. For labor, we examine the effects of the white-/blue-collar composition of the workforce as a proxy for the prevalence of skilled/unskilled workers.[41] For resource allocation, the available regressors are the capital-labor ratio, the age of the firm, and its size. The latter is measured by both value added and output. For size and age, we allow nonlinear effects by including quadratic terms.[42]

Not all regressors are available in every year. The composition of the capital stock (foreign and used machinery, as well as computers) is available in 1986–95. The ratio of exports to sales is unavailable prior to 1989. The only observations for which all candidate regressors are simultaneously available are 1989–95.[43] For this reason we present two sets of results: for 1989–98 (excluding variables describing the composition of capital) and 1989–95 (including such variables). Descriptive statistics for the dependent and independent variables are shown in Table 4.22.

Parameter estimates from the regressions appear in Table 4.23. Note that generally the regressions possess satisfactory explanatory power given the huge sample sizes, especially in the equations with TFP level as the dependent variable. Nevertheless, the *R*-squared measures suggest that unobserved factors are responsible for much of the variation in TFP and its growth rate. The estimated parameters are in all cases significant jointly, as implied by the Wald statistics. Finally, these regression results should be interpreted

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[41] For 1996–98 PIA also includes information on the ratio of foreign materials to total materials used. However, the composition of the capital stock is unavailable for these years. We nevertheless performed some additional regressions, using only 1996–98 data, to assess how the composition of intermediate goods affected TFP and its growth rate. The results were never significant, so we do not report them here.

[42] In addition, the regressions include regional dummies (invariably insignificant and hence not reported here) and the inflation rate (to control for cyclical factors) rather than the effect of inflation itself. Because its coefficient seems uninformative, it is ignored here. In addition, additional experiments were performed to assess the determinants of firm-size change, the impact of labor regulations, and the determinants of investment. These experiments are described in detail in Muendler (2001b).

[43] Ignoring the information on the composition of intermediates, which is available for 1996–98 only.

Table 4.22. Descriptive Statistics for Alternative Samples

	TFP				TFP growth			
	1989–98		1989–95		1989–98		1989–95	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Trade								
Tariffs	0.2288	0.1470	0.2125	0.1315	0.2110	0.1384	0.1978	0.1186
Real exchange rate	1.0006	0.1299	1.0444	0.1396	1.030	0.1362	1.0655	0.1366
Exports-to-sales ratio	0.5627	0.1370	0.0587	0.1361	0.058	0.1358	0.0590	0.1334
Foreign penetration	0.0651	0.0635	0.0611	0.0587	0.0644	0.0612	0.0621	0.0594
Knowledge								
Used machinery to total machinery			0.0586	0.1505			0.0579	0.1479
Imported machinery to total machinery			0.0467	0.1191			0.0489	0.1209
Computer equipment to total machinery			0.0070	0.0124			0.0071	0.0120
Skilled employees to total workers	0.2514	0.1748	0.2614	0.1767	0.2521	0.1739	0.2585	0.1744
Resource allocation								
Age	25.5432	16.7961	27.3608	16.54	27.0833	16.8392	27.8095	16.5874
Size (output)	5.49E+07	2.74E+08	6.33E+07	3.04E+08	6.06E+07	3.02E+08	6.73E+07	3.27E+08
Physical investment								
Capital-labor ratio	9841.54	25046.65	9232.446	24747.6	9529.551	24372.42	9080.968	24157.72
Total factor productivity								
TFP	5.944	2.0232	6.009	2.0440				
TFP growth					0.0438	0.3863	0.0514	0.3774

Table 4.23. Regression Coefficients from TFP Level and Growth Equations

	TFP		TFP growth	
	1989–98	1989–95	1989–98	1989–95
Trade				
Tariffs	–0.1688**	–0.0543**	–0.1449**	–0.2299**
Real exchange rate	–0.0580**	–0.0106	–0.9248**	–0.9809
Exports-to-sales ratio	–0.0741**	–0.1477**	–0.1239*	–0.2057*
Foreign penetration	1.6274**	0.9048**	–0.7590**	–0.6825**
Knowledge				
Used machinery to total machinery		0.0023		–0.0010
Imported machinery to total machinery		0.0557		0.0268
Computer equipment to total machinery		2.0329**		1.3266**
Skilled employees to total workers	–0.0057	0.0317	0.0642**	0.1157**
Resource allocation				
Age	–0.0301**	–0.0049	–0.0333**	–0.0519**
Age-squared	–0.0001**	–0.0002**	0.0000	0.0001
Size (output)	2.19E-09**	2.41E-09**	1.47E-09**	1.70E-09**
Size-squared	–1.95E-19**	–1.95E-19**	–1.25E-19**	–1.35E-19**
Physical investment				
Capital-labor ratio	–8.05E-07**	1.92E-06**	7.97E-07**	3.25E-06**
R^2 within	0.1373	0.1018	0.0653	0.0838
No. of observations	30,913	15,739	20,679	12,164
Wald test of joint significance of all parameters (*p* value)	0.0000	0.0000	0.0000	0.0000

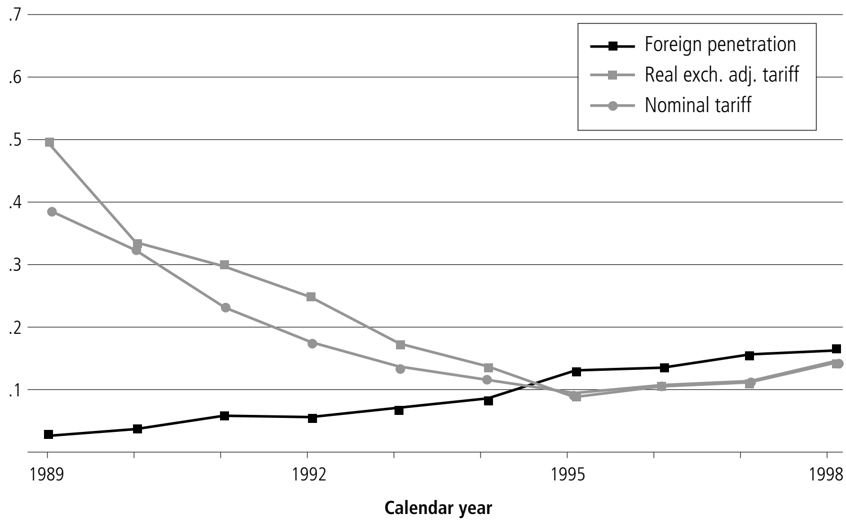
*Coefficients are statistically significant at the 10 percent level.
**Coefficients are statistically significant at the 5 percent level.

with caution since we cannot exclude possible reverse causation from TFP to some regressors; for example, high tariffs might stem from successful lobbying by low-productivity firms rather than vice versa.

Let us now take up the question sets, one by one.

Trade Barriers. Liberalization proceeded in four stages (Kume, Piani, and Souza, 2000). Reforms in 1987–89 primarily sought the removal of numerous redundant tariffs. The (value-added-weighted) average effective tariff declined from 68 to 39 percent. In the second stage (to 1993), nontariff

Figure 4.5. Nominal Tariffs and Import Penetration, All-Industry Average (1989–98)



barriers were lifted, leaving the real exchange rate and tariffs, which were reduced further until the average effective rate was 15 percent, as the main protective instruments. Tariff reduction picked up again with the advent of the Real Plan in 1994, bringing the average effective rate to 12 percent. Finally, in 1995–98, a partial reversal occurred. Certain rates (on automobiles, consumer durables, textiles) were raised first, and then a generalized 3 percent increase was imposed so that the effective rate climbed back to an average of 15 percent.

Figure 4.5 plots the time path of the average nominal tariff (with and without adjustment for the protection accorded by the level of the real exchange rate) as well as the degree of foreign market penetration (as defined above), with all variables corresponding to the overall industry average. The steep decline in protection after 1989 is apparent, as are the partial reversal of the reform after 1995 and the steady increase in foreign penetration. This general framework conceals significant variation across sectors. One interesting experience is that of the auto and auto-parts industry, which enjoyed one of the highest nominal protection rates prior to liberalization and the highest effective protection rate throughout the reform period (Kume, Piani, and Souza, 2000). In this case the pattern of abrupt tariff decline and reversal is particularly striking, as is the steady increase in foreign penetration despite the partial rollback in the late 1990s of prior tariff cuts.

A few studies have focused on the impact of this reduction in trade barriers on Brazil's TFP. Hay (1997) examines the impact of nominal and effective protection rates on the TFP of a group of large industrial firms. He finds negative effects of both variables, as well as from protection accorded by depreciated real exchange rates, and concludes that both the elimination of nontariff barriers at the end of the 1980s and the tariff reductions in the 1990s (along with domestic deregulation and privatization) had positive impacts on the level of TFP. Rossi and Ferreira (1999) likewise find a strong negative impact of nominal and effective tariffs on the growth rate of aggregate TFP, and conclude that the process of trade opening was a key factor behind the TFP recovery observed in the 1990s. Finally, McKinsey (1998) also spotlights tariff reductions as the main force behind the productivity improvements observed in the auto and auto-parts sectors and underscores the obstacle that high tariffs on capital goods (particularly telecommunication equipment) posed to investment and plant modernization at the beginning of the reform period.

The first group of coefficients in Table 4.23 allows us to assess the impact on TFP of opening up the domestic market to *foreign competition*. A priori, we expect protection via tariffs or the real exchange rate to retard TFP, while market penetration by foreigners and contact with export markets should enhance it.

Starting with tariff levels, we find that higher tariffs are invariably associated with lower TFP levels and growth rates in both sample periods. In the case of TFP levels, however, the association is significant only in the longer sample. In the case of TFP growth rates, the coefficients are significant over both time periods. They suggest a positive effect on TFP growth of around 0.2 percent for each point decline in tariff rates. Thus a 30 percent drop in tariff rates (roughly the average rate decline over the reform period) would yield, other things being equal, a 6 percent acceleration in TFP growth.

In turn, the real exchange rate also carries a uniformly negative coefficient in regressions of both the TFP level and TFP growth rate, although as with tariffs the coefficient is insignificant in the level regression for the 1989–95 sample. More-depreciated real exchange rates provide domestic firms additional protection from foreign competition. They also tend to raise the real cost of imported intermediates and machinery. On the whole, the regression results suggest a higher real exchange rate allows firms to get by with lower or more slowly growing TFP.[44]

Foreign penetration in local markets has a significant positive effect on the TFP level in both sample periods (columns 1–2). However, its negative impact on the subsequent growth rate of TFP (columns 3–4) is somewhat puzzling.

Finally, in the case of export orientation, a negative and significant association with TFP and its growth rate was found in both sample periods, contrary to expectations. We should note, however, that in this experiment a number of key variables are held constant—skill intensity, machinery use, and firm age and size—that other studies have found to be significantly associated with export orientation. Interpretation of this result is therefore unclear.[45]

Knowledge. To explore the second broad issue, the role of knowledge embodied in physical and human capital, we focus on variables describing the composition of the physical capital stock—the ratios of used machinery, imported machinery, and computer equipment to total machinery—and the white-/blue-collar composition of the labor force. It is worth noting that the foreign machinery ratio reflects access to foreign markets on the input side, rather than the output access discussed in the preceding subsection. A priori, one expects all these input-quality and embodied-knowledge measures to be positively related to TFP performance except for the used machinery ratio, which should exert a negative effect.

[44] Caution is necessary regarding this result since the real exchange rate measure included in the regressions lacks cross-sectional variation and only displays time variation. It may thus partly capture the effects of other aggregate shocks affecting Brazilian industry, in addition to the effects of the real exchange rate itself.

[45] Moreover, additional work in progress by Muendler (2002) using a different econometric approach finds that export orientation and TFP show a positive association among Brazilian manufacturers.

Of all the variables just listed, only the skills ratio is available in both sample periods under study. The second group of coefficients in Table 4.23 shows that this ratio has a positive and significant effect on TFP growth in both periods but no significant effect on the TFP level in either period. Regarding composition of the capital stock (available for 1989–95 only), the ratio of computers to machinery is significantly associated with higher TFP and TFP growth, and its coefficient is of large magnitude.[46] In contrast, neither the used nor the foreign machinery ratio exhibits any significant effect on TFP or its growth rate. The latter result, in particular, suggests that quality differences between domestic and foreign machinery are inconsequential from the perspective of productivity.[47] Finally, the same conclusion applies to foreign intermediates: their ratio to total intermediate inputs is not significantly associated with TFP level or TFP growth.

Firm Characteristics and Resource Allocation. Four questions arise concerning the role of resource allocation in the observed patterns of TFP: First, does productivity vary systematically with firm age and size; that is, do newer or smaller companies bring in higher-productivity techniques? Second, does capital intensity bear any relationship to TFP? Third, did more productive firms tend to expand faster than less productive ones? And finally, do labor regulations impose a significant burden on business operations? To answer the first two questions we can look at the third group of estimates in Table 4.23.

In general, looking at *firm age*, older companies exhibit significantly lower TFP and TFP growth rates. For TFP levels, the effect is convex, becoming stronger as firms mature. Its magnitude seems considerable: other things being equal, a one-year increase in age lowers TFP growth by 3–5 percent (note than mean age is around 25–30 years). In interpreting this result, however, it is important to remember that other features which vary systematically with firm age—firm size, for instance—are being held constant.

Firm size is measured both by output and value added, and in both cases we find a strongly significant effect. In the case of value added, the

[46] The computer-to-machinery ratio is generally very small; its sample mean is 0.6 percent.
[47] As noted earlier, the same result was found for foreign intermediates over the shorter 1996–98 sample.

impact is concave: larger firms exhibit higher productivity and faster productivity growth, although beyond a certain size the relationship changes sign. Near the sample mean, a 10 percent increase in size as measured by value added is associated with an increase in TFP of about 0.5–0.8 percent and an increase in TFP growth of roughly the same magnitude. In turn, an increase in size as measured by output yields a more modest, but still positive, impact on TFP.

Table 4.23 shows that *capital intensity* exerts a positive and significant effect on TFP growth in both sample periods. Its impact on the level of TFP, however, is less clear. It is positive in the 1989–95 sample when the variables describing the capital stock composition are available, and negative in 1989–98 when they are not.

Contrary to expectations, the contribution of *firm size changes* to aggregate TFP was negative in several years. Change in firm size acted as a drag on aggregate productivity. This result is worth closer inspection. Therefore we ran fixed-effects regressions with firm size change measured by value added as the dependent variable, and with the same explanatory variables (other than size) used in the TFP regressions summarized above, including the profit rate and the TFP level as additional regressors. On the whole, these regressions had a high explanatory power (with *R*-squared coefficients around 0.20). Their main result is that size change is strongly and positively affected by firm TFP levels. Thus, other things being equal, more-productive firms did tend to expand faster over the sample period. Other things, of course, did not remain equal, and must underlie the negative contribution of firm size change on aggregate TFP growth.[48]

In assessing the impact of *labor regulations*, we focused on the burden posed by dismissal rules on firms' ability to adjust to changing conditions, looking at the share of labor costs in total costs for those firms that were shrinking, since the constraints on labor shedding should be reflected in rising shares of labor costs for those firms. The main finding from these experiments (see Muendler, 2001a) is that shrinking output is indeed asso-

[48] More precisely, while the *unconditional* correlation between size change and TFP level is negative in the sample, the *conditional* correlation (that is, controlling for the other factors mentioned in the text) is significantly positive.

ciated with higher labor cost shares, after controlling for other firm characteristics. Although this seems consistent with the reasoning posited earlier, it is difficult to establish the direction of causality underlying the association. Hence it cannot be viewed as conclusive.

Physical Capital and Investment. Given the earlier result that capital intensity encourages TFP growth, interest naturally turns to investigating the factors that shape firms' investment decisions. Our final set of empirical experiments involved the estimation of investment equations relating fixed capital formation to a set of real and financial variables. Among the real regressors, we added the firm's TFP level and its capital-to-output ratio to the variables used thus far. The financial variables included the ratios of profit and credit to output and a set of indicators for a firm's financial structure. This analysis yielded two key results. First, TFP affects investment negatively, which might be interpreted as a "catch-up" effect. That is, firms invest precisely to raise productivity, and they begin to slow their investment pace when productivity reaches a sufficient level.

Second, investment is systematically affected by financial variables such as the profit ratio, the ratio of credit to output, the ratio of long-term credit to the total, and the credit-to-equity ratio. The first three variables are positively associated with investment; the fourth is negatively related. It is tempting to conclude that this reflects the action of financial constraints on firm investment. However, as in the earlier query about labor regulatory burdens, it is difficult to establish causality. Hence the empirical association of investment with these variables must be interpreted with considerable caution. Other work, however, has found evidence for the existence of credit constraints in Brazilian investment since the Real Plan, increasing our confidence in this interpretation of the results (Thomas, 2001).

Conclusions

On average at the firm level, Brazilian TFP growth was negative in the 1980s before modestly recovering in the 1990s. Performance differed widely by industry, with the auto and electrical equipment industries showing the strongest productivity growth in the 1990s. Less technological sectors—food, textiles, leather, and nonmetallic minerals—showed the worst performance and actually declined in productivity during the decade. The industrial composition of the manufacturing sector in the North and Northeast led to lower TFP growth in these regions relative to the South and Southeast.

TFP and TFP growth regressions across firms within industries suggest that trade opening may have helped raise average TFP by about 6 percent. Market penetration by foreign competitors raised the level of TFP but not its growth rate. On the other hand, export orientation does not raise TFP in the Brazilian data; indeed the relationship is negative. Other findings suggest the importance of technological innovation: higher shares of information technology in physical capital raised both TFP and its growth rate. Complementing this result, firms employing more skilled labor, in the form of a higher white-to-blue-collar ratio, showed faster TFP growth, suggesting that Brazilian human capital investments contribute to TFP growth. Foreign machinery, on the other hand, had no significant effect, calling into question the role this played as a conduit for embodied technological change in recent Brazilian growth. Given evidence from firms elsewhere on the importance of international knowledge flows, this result heightens concern that Brazil's integration into international production is not generating all its potential benefits, perhaps due to a bias toward regional trade, perhaps owing to impediments to technology transfer. Finally, new firms possessed higher and faster-growing TFP, suggesting that measures to ease their entry may be a source of future productivity gains for Brazil.

Household Income Growth and Its Distribution

This section focuses in particular on how much economic growth accrues to the poor. Dollar and Kraay (2000) have recently found that growth in per capita GDP across countries is more or less unrelated to changes in measures of their inequality. This finding can be interpreted in two ways. On one hand it refutes those who claim that growth is an irrelevant measure of welfare, that it is systematically regressive because it is generated and captured by elites. On the other hand, it also suggests that the distribution of growth might be an interesting second statistic to examine since it is essentially "orthogonal," that is, unrelated, to the level of growth. We treat this as an open question for Brazil and attempt to answer it by comparing aggregate income growth patterns with its distribution patterns. The analysis is then extended by examining the underlying causes of both growth and its distribution. We shall return to possible explanations of growth and the pattern it takes later in this section.

Our analysis makes use of stacked household data from 1982–98,[49] contained in Brazil's annual national household survey, the Pesquisa Nacional por Amostra de Domicílios (PNAD). Our approach has two main advantages. First, PNAD has a stratified sample design that makes it representative at the state level. This is useful in itself since one can compare growth in household incomes across different states to assess aspects of state performance. But using household data to compile income growth measures also allows us to focus on income growth among the poor (as well as the general population) and then calculate partial correlation with factors that vary at the household or the local level.

PNAD also has some fairly well-documented shortcomings.[50] In particular, its income measures are rather partial since the questionnaire pays little heed to assessing home production and nonmarket income (important in rural areas). However, for our present purposes, it has one overriding advantage: its comparability across time. Furthermore, the patterns obtained from PNAD are consistent with the regional accounts (see Azzoni et al., 2001), suggesting at least that the conclusions in their general form are robust to any design faults specific to the PNAD survey.

Our measure of income growth is change in log per capita household income.[51] For each year the survey was performed (1982–98, with 1994

[49] In the context of explaining historical patterns in Brazil, comparable data from the 1970s would have been desirable. Unfortunately such data are not available.
[50] See Ferreira, Lanjouw, and Neri (1998) for the most complete discussion of this topic.
[51] For changes of about 10 percent or less, this measure is approximately equal to the percentage change in income. Using log-differences has certain analytical advantages that make it preferable, however. Parts of the analysis were performed using percentage changes in income, without causing undue disparity. The main divergence between the two is that log-differences deflate large (greater than 10 percent, say) income growth figures. The results suggest that this distortion does not excessively harm the main conclusions of this analysis.

missing), two such measures are constructed: change in mean income for the population and change in mean income of the poorest (as measured the previous year) 25 percent of the population. These two measures are then treated as the independent variable in the regression analysis.

The implicit analytic unit for most of the analysis is the state. The presentation of results contains two parts, first descriptive and then analytical. The descriptive overview presents state growth rates in four periods: 1981–85, 1985–89, 1989–93, and 1993–98. The analytical section uses an age cohort within a state as the unit of observation. This allows us to enrich the exercise by adding greater variation in important dimensions such as educational attainment, employment patterns, and access to infrastructure. We lack repeated observations of the same households over time (panel data), but by aggregating within state-cohort cells, we do have repeated observations of cohort means over time (quasi-panel data: see Deaton, 1980). The analysis then uses panel estimation techniques to derive consistent estimates of partial correlations between state-cohort characteristics and state-cohort income growth. Thus, the analysis tries to answer the question: What parts of Brazilian state-level characteristics or policies coincided with income growth within the periods studied?

Hypotheses

To frame the answer to this question, initial hypotheses about what determines or constrains household income growth in Brazil and its states are needed. Many such hypotheses exist, but many of these are untestable using the data and methods of this chapter. The following hypotheses were selected, with notes amplifying the evidence that would support each.

First are *education constraints*. Brazil's low level of workforce education (ranking behind most of its South American neighbors in most statistics) is often cited by investing companies as an impediment to economic activity. So it is natural to posit this as an obstacle restraining growth. If this is so, one would expect to see states and cohorts with more education among the workforce showing significantly higher levels of income growth.

Second is *political and policy uncertainty*. Policy uncertainty has been cited by firms in many surveys as the number-one obstacle to investing in Brazil. It is sometimes difficult to ascertain exactly what comprises this uncertainty: exchange rates, economic ambiguity, and unpredictable legal rulings, among other factors, may all play a part. For present purposes, we focus on the educational level of public sector employees in a state, the frequency of ideological shifts in government, and the volatility of voting patterns as measures of uncertainty that may impede economic growth.

Third are *infrastructure bottlenecks*. Brazil's infrastructure is not worse, overall, than those of its neighbors in many categories. There is, however, great infrastructural variation among the states (e.g., in electrification, water, paved roads, and public services such as garbage collection). If infrastructure were a constraining factor, one would expect to see the states best endowed in these dimensions growing faster, ceteris paribus.

Fourth are *labor rigidities*. Brazil's labor code is onerous by international standards. Again, the extent to which this impedes growth is unclear, but if it is an impediment, then under certain assumptions one would expect to find lower income growth rates in states and cohorts with higher levels of formal labor contracts. The proportion of contracts that are formal is of course endogenously determined as a function of their associated costs and benefits, so the line of analysis suggested in the previous paragraph can only be pursued with some skepticism. However, nearly all the explicit costs of formality are federally imposed and thus invariant across states and cohorts. Variation in the proportion of contracts that are formal must therefore be due to other factors, some of which will be controlled for in the analysis: education and employment composition by sector, for example. Thus one must assume that remaining variation in the extent of formal contracts is exogenous.

Fifth is *climate*. A long strand of economic literature posits that some countries are geographically doomed to lower growth rates owing to climatic conditions that impede economic activity. The most common evidence cited is the negative coefficient on "tropical" dummy variables in cross-country growth regressions. We therefore investigate whether rainfall, latitude, or altitude are associated with differences in income growth rates.

Sixth are *agglomeration and spatial factors*. A related hypothesis holds that poor areas remain poor due to low aggregate demand (so-called trading externalities, discussed theoretically in Diamond, 1982). These effects are therefore also "geographical"[52] but would show up in data as low growth rates associated with low local measures of economic activity.

Seventh are *access to markets and trade volume*. Brazil's economy remains relatively closed despite lowered tariffs in the 1990s. There is also variation in the distance to major markets among the states. If integration were constraining growth, ceteris paribus we would expect to see states furthest from markets, and those trading least, growing more slowly. To attempt to test for these effects we use distance from the sea as a proxy for market access, and interstate trading volumes as a proxy for integration into the national economy.

Eighth is *migration*. Brazil's economic miracle included processes of urbanization, transformation of the productive base from traditional industries toward manufacturing, and migration, particularly from the Northeast to the Southeast regions (see Gordon, 2001). Recently these migratory flows have diminished and even reversed (Fiess and Verner, 2001). It is an interesting question, though hard to answer convincingly, to what extent this has caused Brazil's economic slowdown. Because opportunities for income growth both cause and are caused by migration, most attempts to assess causality are doomed to ambiguity.

Descriptive Results

The main issues we are interested in describing before a discussion of underlying causes are:

- *Income Growth over Time*. How does income growth behave in different periods since 1982? What are the relative performances of the states and regions?

[52] See Jalan and Ravallion (2000) on China.

- *Convergence*. Is there a tendency for poor states to catch up with richer ones? If so, how fast?
- *Income Growth among the Poor*. To what extent does income growth accrue to the poor? How does this vary by state and region?
- *Changes in Inequality*. What are the effects of income growth, and its accrual to the poor, on inequality? Has inequality risen or fallen? Is there a "trade-off" between income and inequality?

For convenience we divide the full period 1981–98 into four approximately five-year subperiods: the early 1980s including and following the debt crisis (1981–85); the late 1980s including and following the Cruzado Plan (1985–89); the early 1990s including and following the Collor Plan (1989–93); and the late 1990s including and following the Real Plan and stabilization (1993–98).

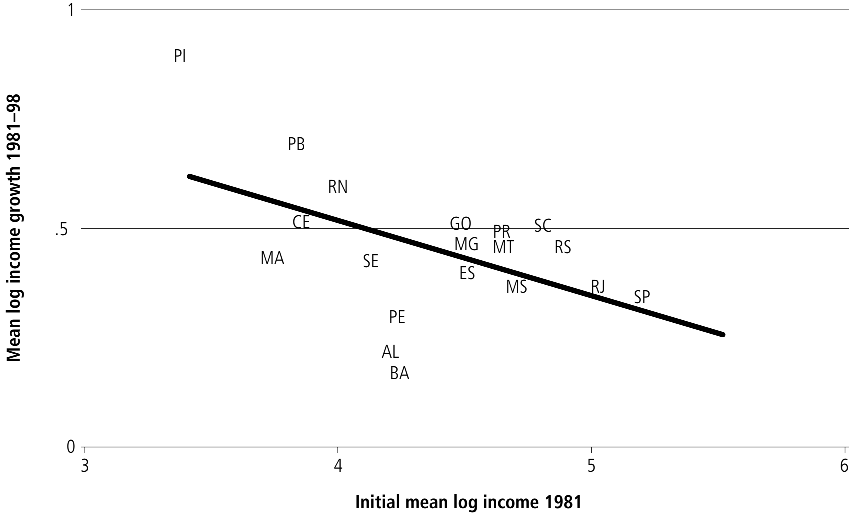
Figure 4.6 plots state household-income growth (vertical axis) versus initial household per capita income (horizontal axis) for the whole period. One can see the great divergence in states' growth rates, although only 19 of Brazil's 27 federated units are shown in the diagram for various reasons. The Federal District comprising Brasília and neighboring towns is not a state. Also, the states of Brazil's Northern region[53] have been excluded since they are special cases, exhibiting "frontier" characteristics. They have extremely variable growth rates, mainly owing to waves of immigration and exploitation of natural resources (e.g., oil in Roraima), and their inclusion would obscure more than it would reveal.

There is some evidence of states falling into regional blocks.[54] Brazil's regions are to some extent economically homogeneous clusters. The South-

[53] The states of Rondônia, Acre, Roraima, Amapá, Pará, and Amazonas. The state of Tocantins, which only separated from Goiás in 1991, has been merged with Goiás for the purpose of comparability across time.

[54] Brazil has standardized definitions of its regions. The Southeast comprises São Paulo (SP), Rio de Janeiro (RJ), Minas Gerais (MG), and Espírito Santo (ES). The South comprises Rio Grande do Sul (RS), Santa Catarina (SC), and Paraná (PR). The Center-West comprises Mato Grosso (MT), Mato Grosso do Sul (MS), Goiás (GO), and the Federal District (DF). The Northeast comprises Bahia (BA), Sergipe (SE), Alagoas (AL), Pernambuco (PE), Paraíba (PB), Rio Grande do Norte (RN), Ceará (CE), Piauí (PI), and Maranhão (MA).

Figure 4.6. Initial Income and Income Growth (1981–98)



east (SP, RJ, MG, and ES) is richest and forms the industrial powerhouse of the country. The South (RS, SC, and PR) is also relatively wealthy but more agricultural and less industrial than the Southeast. The Center-West (MT, MS, GO, and DF) is poorer than the first two regions and relies mainly on natural resources and agriculture. Its infrastructure is far less developed than that of the South and Southeast. The Northeast (PI, PB, RN, CE, MA, SE, PE, AL, and BA) is much poorer. The Northeast's 28 percent of the national population accounts for only 13 percent of GDP. Its interior includes a large semiarid expanse, the Sertão, which contains Brazil's most extreme problems of rural poverty. Infrastructure and social indicators are also much less advanced in the Northeast.

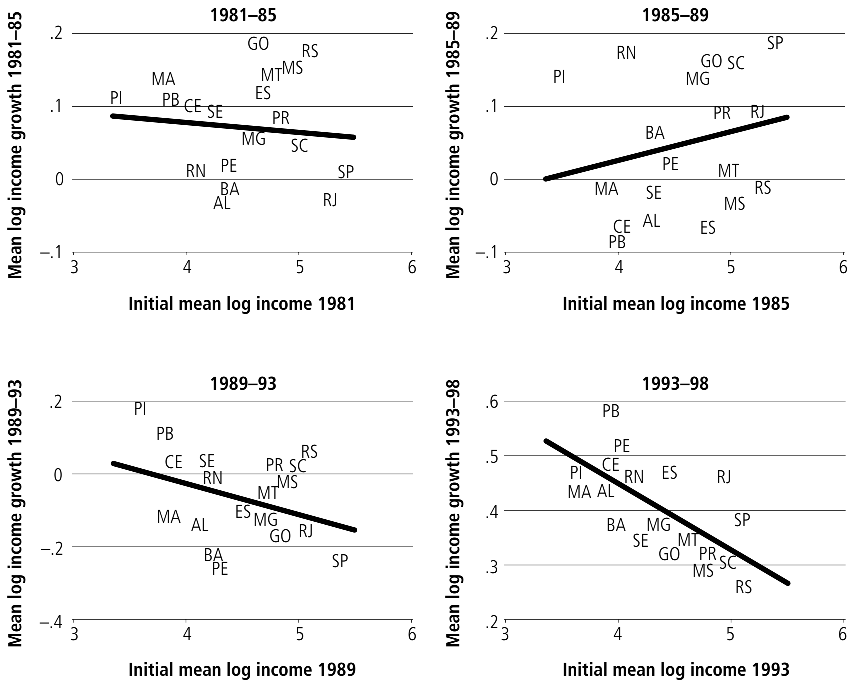
The states within each region differ to a greater extent in their public policies. Evidence of clustering into regional growth performance is therefore evidence that initial conditions or conditions that change only slowly (levels of industrialization, some social indicators such as adult literacy) are responsible for a large part of the growth differentials. In this context, differences between seemingly similar states within the same region are notable, although a more analytical approach is needed to try to disentangle the causes. The South, Southeast, and Center-West all show less intraregional variation than does the Northeast in Figure 4.6. In the Southeast, for example, the states of Rio de Janeiro and São Paulo are neighbors on the graph. Paraná, Santa Catarina, and Rio Grande do Sul in the South all had near equal income in 1981 and showed similar growth rates over the period. This suggests that for these regions initial conditions and national considerations dominated state policies in determining economic growth.

The Northeast is another story. The region contains Brazil's fastest-growing state over the period (within the 19 we are discussing)—Piauí—and the slowest—Bahia. Despite starting from similar initial incomes, the states of this region displayed widely divergent growth rates over the period. What can explain this? We will argue that at least part of the reason is state public policy.

Figure 4.7 illustrates growth versus initial income for states in each of the four periods separately. The periods do not resemble one another very much graphically, supporting the argument of the previous paragraph. The PNAD data confirm, at the microeconomic level, the macroeconomic observation that the 1980s were a "lost decade." For 1981–85, four states record negative or zero real per capita household income growth in the data. For 1985–89 the story is worse. The 19 states are split about in half between those that record negative or zero per capita income growth and those that record positive growth. And the recession of 1991–92 creates even worse effects in the third period, when only seven states show positive growth. Positive growth returns to the micro data just as it does to the macro data only after 1993. The dispersion among states is also slightly higher in 1989–93 than it is in 1993–98.

Some of the regional clustering that was apparent for the whole period is less so within subperiods. A closer look at the data reveals that the bulk of the growth over the whole period is accounted for by what occurs in the fourth period. Regional clustering also is most apparent during this period, even for the Northeast, though that region still shows greater intraregional growth variation than the other three.

Figure 4.7. Initial Income and Economic Growth in Four Periods



Convergence among States

A now extensive literature discusses the concept of economic convergence between countries, that is, the notion that—for reasons of technological imitation, factor mobility, and higher returns to scarce factors such as capital (physical and human)—poor countries ought theoretically to be able to "catch up" with rich countries. The cross-country evidence is mixed, and there are many reasons why "theoretically" may accord with inappropriate theory. Nonetheless, the theories that imply convergence between countries ought to apply more readily to states within the same country. Obstacles to factor mobility and to technological imitation are fewer. Moreover, many institutional parameters are fixed at the country level and, therefore, to a first approximation are fixed across states, bringing the implicit ceteris paribus assumption behind growth comparisons a little closer to reality.[55]

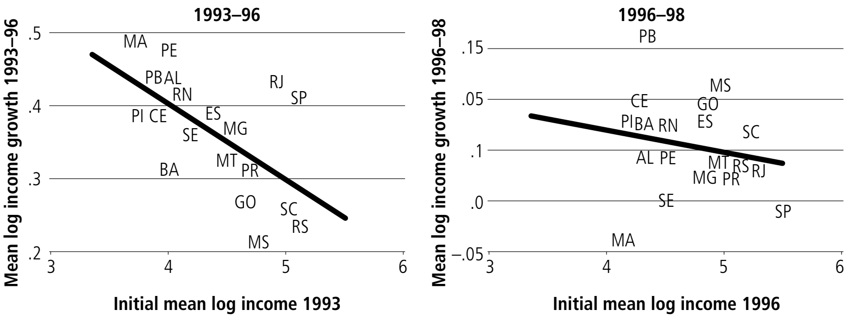
Figure 4.7 shows quite clearly that if convergence has occurred at all in Brazil since 1981, it has only been since 1993, or possibly, if one reads the third graph charitably, since 1989.[56] In the three earlier periods there is simply no visual (let alone statistically significant) relationship between initial levels of income and subsequent income growth. Since the Real Plan, however, there is a striking relationship: poorer states, particularly in the Northeast, have exhibited faster income growth. This is no doubt partly because greater macroeconomic stability allows longer-term planning and investment, clearly a necessary component of the convergence story. It is also partly because the costs of high inflation had been borne disproportionately by the poor, who could not protect themselves by asset switching as effectively as richer households. The elimination of inflation in 1993–95 therefore generated relative gains for the poor.

Which of these two explanations better fits the data can be suggested by dividing the post-1993 period in two: 1993–96 and 1996–98. Gains from eradication of inflation were concentrated in the first subperiod. Gains from greater stability and long-term investment only began to be felt in the second. Figure 4.8 shows what happened to convergence in these subperiods and illustrates that the early part of the Real Plan accounts for a large part of the convergence effect of the fourth period (1993–98) as a whole. It is likely that eradication of inflation had beneficial consequences that helped the poor. Earlier changes, such as the trade opening, may also have changed market structures during this period in ways that helped the poor. We therefore hypothesize that the speed of convergence between 1993 and 1996 may be difficult to recreate without explicit regional initiatives. A final note in

[55] See Barro and Sala-i-Martin (1991) for an analysis of convergence applied to states and regions in the United States and Europe over the long run.

[56] The literature makes an important distinction between conditional and unconditional convergence. The former is understood to mean relative catch-up in residual income after controlling for many factors such as education and governance, which are at lower standards in poorer countries. Our discussion in this section limits itself to the simpler concept of unconditional convergence between states. Azzoni, Menezes-Filho, and Menezes (2001) use the same data to investigate conditional convergence among Brazilian states and find some supporting evidence.

Figure 4.8. Results from Bifurcating the 1993–98 Period



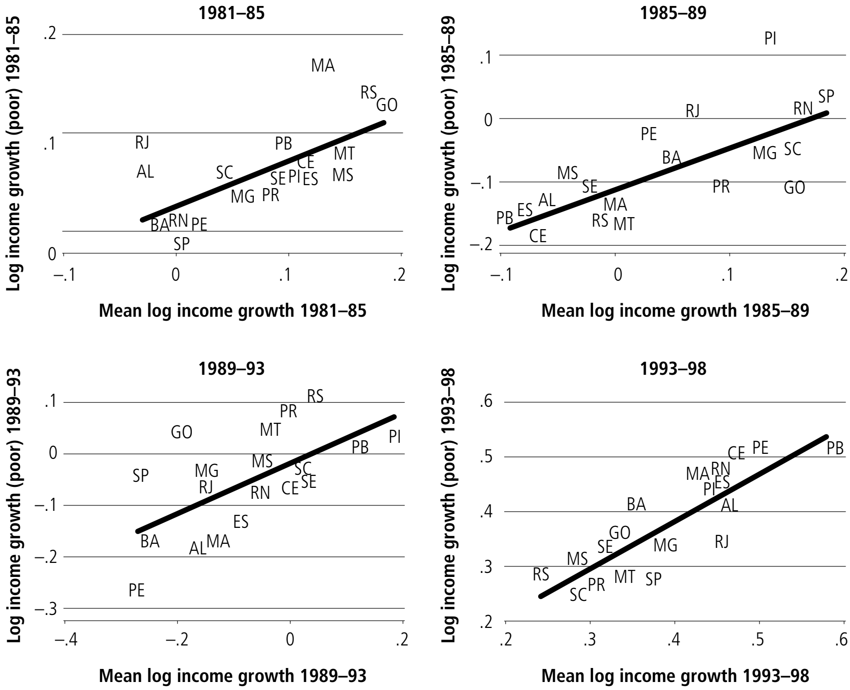
this regard: the evidence from elsewhere does not suggest that one should expect "automatic" and rapid convergence of Brazil's poorer states with its richer ones. Barro and Sala-i-Martin's (1991) analysis of Europe and the United States suggests conditional convergence of around 2 percent annually. This corresponds to a catch-up "half-life" of about 35 years.

Income Growth among the Poor

Figure 4.9 plots the rates of income growth among the poor versus general income growth, for the whole period and each subperiod. Between 1981 and 1998 the income of the poor grew at a lower rate than the income of the whole population. Inequality thus increased. A related observation is that the slopes of the lines of best fit in the four quadrants of the figure have slopes of less than one. In terms of a thought experiment in which a "less successful" state takes on the growth characteristics of a "more successful" state, this would mean that the poor would benefit less than the state's population as a whole. The situation does improve in the fourth period, however, as the respective slopes of the lines are 0.46, 0.63, 0.48, and 0.90.

Perhaps unsurprisingly, the order of states by economic growth over the period does not markedly change whether one considers the poor or the whole population. Indeed, in the fourth period the rank correlation in these data between average income growth and income growth among the poor is 0.83. Nonetheless Figure 4.9 shows variation between one measure

Figure 4.9. Income Growth among the Poor in Four Periods



and the other, so that even if the choice of measure makes little difference to the ordering of states, focusing on the difference between the two measures is of interest.

Figures 4.10 and 4.11 plot a measure of the "equality" of growth against the quantity of growth for the whole period and then each of the four subperiods. This definition of equality derives from the remainder in difference measures applied to log income: that is, income growth is calculated (as the difference in log income) for the whole population of a state and subtracted from the same measure restricted to the poor.[57] Thus if income among the poor grew faster than the average, then the equality measure is greater than zero, showing that inequality decreased. If in-

[57] The ability to construct such a decomposition is an advantage of using the log-difference specification of growth.

Figure 4.10. Growth: Quantity and Equality (1981–98)

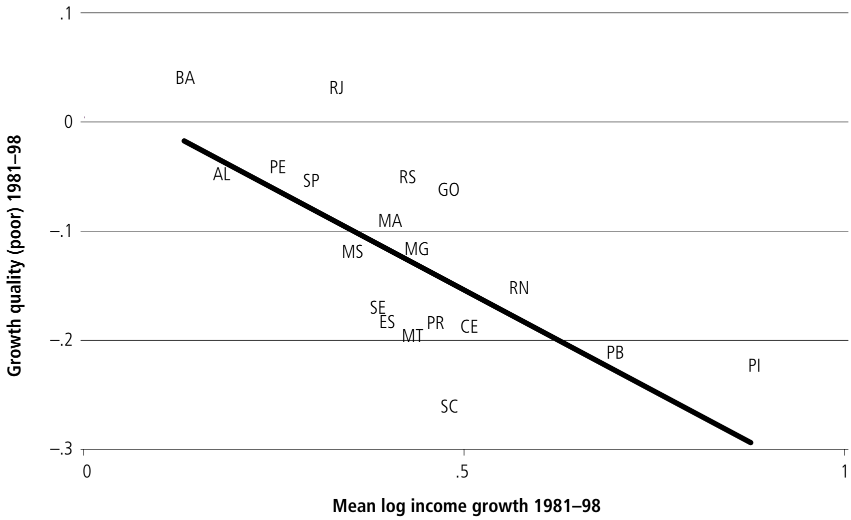
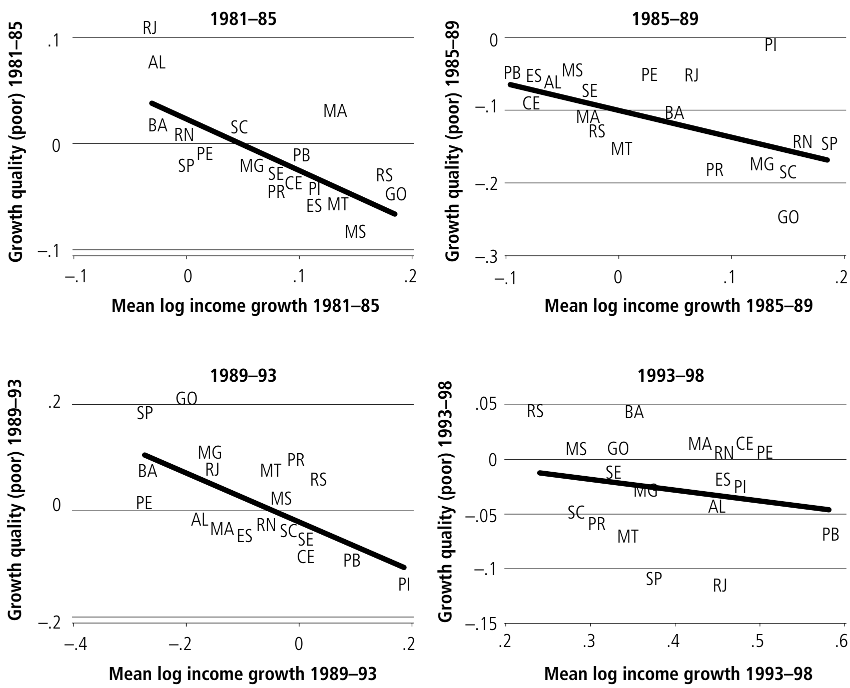


Figure 4.11. Growth: Quantity and Equality in Four Periods



equality was constant or increased, the remainder is zero or negative, respectively.

There has been a systematic relationship between growth and its distribution. Any trade-off between growth and inequality—between quantity and equality of growth—would show up in these graphs as a downward line of best fit. For the period as a whole, the line of best fit is downward and has a statistically significant slope of –0.38. The slopes of the lines of best fit for the four subperiods are –0.54, –0.37, –0.52, and –0.10, with the first three significantly different statistically from zero (at a 5 percent level of significance), and the last one not. It is to be hoped that the significant negative relationship between quantity and equality has disappeared entirely since the Real Plan, but this may be overoptimistic given the propoor effects of the one-time fall in inflation. It would therefore not be surprising were the "growth-inequality trade-off" of the earlier periods to return in the near future.

If the income growth of the poor coincides with broader income growth, and if inequality changes are (recently) unrelated to income growth, then one would expect poverty reduction to occur in states where higher income growth occurred. This is indeed the case. The three states with the highest income growth in the period, the small Northeastern states of Piauí, Paraíba, and Rio Grande do Norte, also saw the largest drops in the poverty head count rate.[58] São Paulo and Rio de Janeiro had the lowest declines in the poverty rate and were among the bottom five states with the lowest rates of economic growth during the period.

In summary, although there was an apparent trade-off in Brazilian household data between economic growth and inequality until the Real Plan, this trade-off diminished or disappeared in the data after 1993. Economic growth is highly correlated with the growth of the incomes of the poor and thus with poverty reduction. However, income growth has not accrued proportionately to the poor. For each 1 percent of general income growth over the whole period (1981–88), the income of the poor rose by a

[58] The poverty head count cited here uses a food-poverty line, and is often also known as the extreme poverty rate, or *taxa de indigência*.

little over a half percent. This ratio has risen to about 0.9 since the Real Plan, but some of this improvement may not be sustained beyond the period of inflation eradication.

Almost all the significant growth in real household incomes in the period has occurred since 1993. Economic stability is clearly a sine qua non for improved household welfare, whether of the poor or of the population at large. Over the same period, there has been unconditional convergence in states' incomes. Moreover, "regional fixed effects" in growth are strongly evident, suggesting the importance of initial conditions, economic structure, and national policies in determining growth, seemingly dwarfing state policy parameters in their effects.

Econometric Results

We now turn to more structural explanations of the above patterns. First, growth observations are pooled for each year (1981–97 since first differences are used), state (19 in our sample), and age cohort (10 defined in our sample). The aim is to establish which state- and cohort-level variables are correlated with economic growth; pro-poor economic growth; and at a later stage, the difference between the two, which corresponds with our difference-in-differences equality measure described above. All reported estimates were calculated using first-difference or quasi-first-difference GMM estimation. In first-difference specifications, variables that are not strictly exogenous are instrumented with lagged levels of right-side variables, following the methodology proposed by Arellano and Bond (1991). Similar results were generated from simpler but less econometrically defensible estimation techniques such as OLS with state-cohort fixed effects, although where there was divergence in results we weaken our conclusions accordingly. Tables 4.24 and 4.25 describe the variables used in the analysis.

Income Growth across States. The first column of Table 4.26 reports coefficients from the regression of observations on overall income growth, pooled over the whole period, on the right-side variables. The corresponding OLS specification in first-differences explained 67 percent of the variation in

Table 4.24. Summary of Variables Used

Variable name	Description	Mean	Standard deviation
Dependent variables			
Delta	Difference in mean log income in cell over the year	0.0317	0.231
Delta25	Difference in mean log income of the poorest quartile	0.0215	0.231
Quality	Difference in differences: Delta25-Delta	–0.0119	0.159
Weakly exogenous variables			
Education	Average completed years of schooling of household head	3.51	1.57
Primary	Fraction of cell with completed primary education	0.691	0.189
Middle school	Fraction of cell with completed lower secondary education	0.154	0.125
High school	Fraction of cell with completed high school education	0.103	0.076
College	Fraction of cell that attended college	0.052	0.042
Public admin.	Average years of education of state's public employees	7.14	2.62
Political	Sum of squares of changes in parties' vote shares	0.411	0.287
Policy	Indicator of change in political leaning of governor	0.529	0.499
Electric	Percentage of electrification in the state	0.773	0.169
Trash	Penetration rate of garbage collection in the state	0.500	0.200
Industry	Fraction of households in cell with industry employee	0.190	0.108
Agriculture	Fraction of households in cell with agricultural employee	0.326	0.136
Services	Fraction of households in cell with services employee	0.366	0.139
Urban	Fraction of cell that lives in an urban area	0.659	0.144
Formal	Fraction of households with head formally employed	0.216	0.150
Rain	Annual rainfall (cm)	103.1	24.6
Latitude	Average latitude of the state (degrees)	13.34	7.10
Altitude	Average altitude of the state (m)	328.6	164.9
Distance	Average distance from the sea (km)	226.1	204.2
Migration	Fraction of population that immigrated from out of state	0.146	0.109

Note: "Cell" refers to by-state, by-cohort groupings.

income growth, a high proportion for quasi-panel data. The significant effects are from average years of education, the political and policy variables, the penetration rate of garbage collection, and the level of employment in industry and services (that is, in relative terms agriculture fared poorly).

Many studies find positive relationships between the amount of education and income (whether analyzing households, countries, or other levels of aggregation). All of the literature on returns to education falls

Table 4.25. Evolution of Selected Variables

Variable	1981	1985	1989	1993	1998
Log income	4.41	4.48	4.52	4.50	4.91
Log poor income	3.51	3.56	3.48	3.44	3.84
Education	3.22	3.36	3.47	3.66	3.90
Primary	0.779	0.738	0.691	0.658	0.583
Middle school	0.106	0.125	0.152	0.176	0.212
High school	0.0640	0.0910	0.105	0.114	0.142
Tertiary education	0.0506	0.0454	0.0524	0.0525	0.063
Public administration	6.99	6.62	6.91	7.15	8.06
Electric	0.620	0.694	0.772	0.840	0.900
Trash	0.336	0.423	0.477	0.585	0.673
Industry	0.258	0.202	0.196	0.160	0.128
Agriculture	0.354	0.379	0.332	0.300	0.268
Services	0.376	0.403	0.428	0.309	0.287
Urban	0.615	0.627	0.640	0.703	0.709
Formal	0.294	0.273	0.258	0.161	0.117

within this category, for instance. Yet for our education coefficient, this is not exactly the case. Rather, we are reporting a significant positive relationship between the *initial level* of education (of an age cohort in a state) and the subsequent *rate of growth* of income (by that age cohort in that state). It is far from obvious that one would find such a robust effect in the Brazilian data (the coefficient is also large, approximately 0.1, implying that an extra year of average completed education increases subsequent income growth by 10 percent). Similarly, it is worth noting that political and policy uncertainty both have the expected signs and are significant. States with uncertain political outcomes, or where the governorship moved between different points on the ideological spectrum, grew more slowly. The effect of the variable *trash* is interesting. This variable is a proxy for public provision of infrastructure. The interpretation of this effect equates to a direct impact of the infrastructure level on productivity growth. This effect could also be viewed as an indicator of geographic effects; that is, the same people would have higher income growth if they lived in a richer location.

The second column of Table 4.26 reports the coefficients from the same estimation when restricted to the later two subperiods described earlier, covering 1989–98.[59] The education effect is almost identical, while the infrastructure effect (from *trash*) is still significant though smaller. There is also now a significant effect from the other infrastructure variable, the level of electrification in the state. Political uncertainty increases in importance, while policy uncertainty does not appear significant. This difference in the behavior of the sector variables across the two periods (1981–98 versus 1989–98) may reflect the true underlying differences in productivity growth across time. Finally, there is a significant positive effect from the proportion of workers in the formal sector.[60]

Income Growth among the Poor. Column III of Table 4.26 reports coefficient estimates using the sample from the whole period restricted to the poor.[61] The results are strikingly different from those in column I. First, education does not appear to be significantly correlated with income growth among the poor. We repeat here that education is undoubtedly correlated with income for this sample of households, but not necessarily with its subsequent rate of growth. Political uncertainty, however, appears with almost an identical negative coefficient to that in column I. Next, the infrastructure effects are attenuated, though similar in pattern to those in column I. Finally, there are no marked effects from the sector composition of employment. All in all for 1981–98, income growth among the poor seems harder to explain than among the general population.

Column IV reports the same results for 1989–98. The education effect is again absent, while the effects of political uncertainty are heightened. The infrastructure variables seem to swap roles relative to column II, with electrification (*electric*) highly significant and *trash* less so. There is no significant effect among the sector variables, although the highest point estimate is for the industrial employment variable.

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[59] For contemporary relevance one would prefer to restrict even further to, say, 1993–98, but this is unfeasible econometrically since the methodology being used requires sufficient variation in the regressors across time to identify effects.

[60] This effect was absent from the OLS specifications and also from the longer time period.

[61] The definition of *poor* for the purposes of calculating income growth in this section is the same as that used in the previous section, namely, the bottom quartile of individuals in the data.

Table 4.26. Income Growth Equation Coefficients
(absolute Z-values)[a]

	I	II	III	IV
Period	**1981–98**	**1989–98**	**1981–98**	**1989–98**
Dependent variable	**Delta**	**Delta**	**Delta25**	**Delta25**
Coefficients				
Education	0.103**	0.104**	–0.0076	–0.024
	(7.20)	(6.38)	(0.51)	(1.29)
Public administration	0.0068**	0.0034	–0.0002	–0.0020
	(3.37)	(1.36)	(0.10)	(0.82)
Political	–0.044**	–0.055**	–0.042**	–0.051**
	(2.27)	(2.93)	(2.23)	(2.63)
Policy	–0.013**	–0.0017	–0.0062	–0.0002
	(2.61)	(0.16)	(1.09)	(0.02)
Electric	0.126	0.343**	0.095	0.402**
	(1.44)	(3.12)	(1.10)	(3.68)
Trash	0.361**	0.605**	0.194*	0.264*
	(4.04)	(4.79)	(1.71)	(1.73)
Industry	0.177*	0.361**	0.106	0.183
	(1.95)	(1.98)	(1.09)	(0.93)
Agriculture	0.152	0.334**	–0.021	0.092
	(1.38)	(2.37)	(0.22)	(0.63)
Services	0.209**	0.591**	–0.080	0.074
	(1.97)	(4.00)	(0.75)	(0.51)
Urban	–0.038	–0.324**	–0.071	–0.223
	(0.32)	(2.06)	(0.59)	(1.39)
Formal	–0.083	0.085	–0.156	–0.144
	(0.74)	(0.54)	(1.28)	(0.79)
Lagged dep. variable	0.334**	0.327**	0.153**	0.233**
	(12.76)	(9.31)	(4.19)	(5.32)
R^2 from OLS	0.67	0.52	0.63	0.43
Number of observations	2,890	1,853	2,890	1,853
Number of groups	190	190	190	190
Mean number of periods	15.2	9.8	15.2	9.8

[a] All statistics are calculated from robust standard errors.
* Coefficients are statistically significant at the 10 percent level.
** Coefficients are statistically significant at the 5 percent level.

Taken together, these results suggest that there is far less systematic correlation between state-cohort characteristics and economic growth among the poor than there is in the economy as a whole. This is in itself an interesting finding. One may now ask whether the differences between the coefficients for the two groups are significant. Since the *difference between income growth* among the poor and among the whole population is precisely our measure of the *equality of growth* from the previous section, this equates to regressing our equality measure on the same variables.

This recalls the notion discussed earlier, and commonly voiced in economic debates since Kuznets, that trade-offs may exist between the pursuit of economic growth as an end in itself and the distribution, or equality, of that growth. To the extent that individual variables appear with a significantly smaller coefficient in regressions of income growth among the poor than in regressions of general income growth, these variables may be thought of as microlevel incidences of such trade-offs.

The first column of Table 4.27 shows the results from regressing growth equality on the right-hand side variables. As expected given the results so far, educational attainment appears with a highly significant negative coefficient. For the period 1981–98, improvements in education across Brazilian states seem to have benefited the population as a whole more than they did the poor. On the other hand, industrial employment appears with a significantly "better" positive coefficient than employment in either agriculture or services. Over the whole period industrial employment was significantly correlated with income growth (Table 4.26), and moreover its differential effects relative to agriculture and services have been greater among the poor. Policy stability also has a small but significant effect on income distribution. Finally, the quality of public administration seems to have had a slightly inequitable impact on growth, though the point estimate of this effect is very small.

The corresponding results results for the period 1989–98 are reported in Table 4.27, column II. The results are similar, suggesting that the effects reported in the previous paragraph are not solely due to including 1980s data. In 1989–98, education again appears to have greater growth effects on average than among the poor. The main differences between the 1990s and the whole period lie in the sector and infrastructure effects. Services now appear with a significantly larger negative coefficient; that is, it appears that service income growth has not benefited the poor relative to

Table 4.27. Equality Equation Coefficients
(absolute Z-values)

Period Dependent variable	I 1981–98 equality	II 1989–98 equality	III 1981–98 relative equality	IV 1989–98 relative equality
Coefficients				
Education	–0.114**	–0.135**	–0.113**	–0.144**
	(7.93)	(7.44)	(6.00)	(6.05)
Public administration	–0.0052**	–0.0040	–0.0044*	–0.0051
	(2.62)	(1.59)	(1.86)	(1.60)
Political	0.0135	0.0136	–0.037	–0.0087
	(0.65)	(0.65)	(1.01)	(0.24)
Policy	0.0117**	0.0059	–0.015**	–0.0008
	(2.21)	(0.48)	(2.00)	(0.05)
Electric	–0.151	–0.131	–0.129	0.052
	(1.62)	(1.15)	(1.08)	(0.29)
Trash	–0.124	–0.281**	–0.271*	–0.590*
	(1.21)	(2.17)	(1.85)	(2.74)
Industry	–0.118	–0.358*	–0.145	–0.312
	(1.31)	(1.72)	(1.05)	(1.23)
Agriculture	–0.299**	–0.469**	–0.667**	–0.887**
	(3.46)	(3.35)	(4.25)	(3.44)
Services	–0.313**	–0.559**	–0.431**	–0.608**
	(2.78)	(3.71)	(3.09)	(3.04)
Urban	–0.068	0.093	–0.309*	–0.110
	(0.50)	(0.46)	(1.65)	(0.42)
Formal	–0.066	–0.059	–0.063	–0.129
	(0.58)	(0.34)	(0.38)	(0.52)
Lagged dep. variable	0.170**	0.168**	0.139**	0.214**
	(4.60)	(3.93)	(3.13)	(3.93)
R^2 from OLS	0.28	0.26	0.24	0.23
Number of observations	2,707	1,685	2,707	1,685
Number of groups	171	171	171	171
Mean no. of periods	15.8	9.9	15.8	9.9

*Coefficients are statistically significant at the 10 percent level.
**Coefficients are statistically significant at the 5 percent level.

the whole population. Finally, *trash*, the variable proxying for local infrastructure, now appears with a significant negative coefficient.

Columns III and IV of Table 4.27 explore a further concept of income distribution: equality of growth interpreted as its incidence among the poorest 25 percent *within each state*. This changes the emphasis from the income distribution at a national level to the distribution at the level of individual states. The person at the 25 percent point of the income distribution in São Paulo, for example, is above the extreme poverty line used for this and other studies.[62] On the other hand, much more than 25 percent of the population of, say, Ceará fall below this boundary (indeed more than half do). It is worthwhile to check whether the same broad results hold if one interprets poverty as "relative" rather than "absolute." Seemingly, the results do not change very much, with two exceptions. As column III (Table 4.27) shows, for the entire period 1981–98, the policy uncertainty variable expresses a significant negative coefficient. Also, relative to column I, agricultural employment was significantly less pro-poor (in our newly relative terms) than was industry.

For 1989–98 the picture is similar, even if the coefficients alter somewhat. Education and infrastructure (through garbage collection rather than electrification as a proxy) again express negative coefficients. Agricultural employment again seems to be the precursor of inequitable growth, with an even higher negative coefficient than for the whole period.

Distinguishing among Levels of Education. Since the analytic results regarding education are robust thus far and also important from a policy perspective, the next step is to assess differences by education level. Table 4.28 reports coefficients from equations that included measures of the development of different levels of schooling (primary, lower secondary, high school, and college). Since we are mainly interested in the *differential* effects of the various educational levels, the coefficients we report are the differences between the effects of secondary, high school, and college attendance measures and those related to no education or just some primary school attendance. Moreover, for digestibility we restrict to the period 1989–98 and omit mention of all other coefficients. The results for the other coefficients are very similar anyway to those reported in Tables 4.26 and 4.27 and would distract focus from analysis of education.

[62] The poverty line is defined in absolute terms at R$65 (measured in São Paulo in 1997), and adjusted for regional price variations (Azzoni and Menezes, 2000). Since the poverty rate measured this way varies greatly across states, there is a significant difference between the concepts of absolute and relative poverty as defined in the text.

Column I reports the results of the general income equation estimation, while column II restricts to the (absolute) poor. Column III then reports the point estimates of the effects of the different levels of education on our measure of equality. Column IV (analogous to columns III and IV of Table 4.27) investigates the notion of relative equality defined above. Significant results are what one might expect. College enrollments, despite their positive (though statistically insignificant) effect on income growth, increase subsequent income inequality in these data. This may seem unsurprising, but taking the data at face value nonetheless reinforces the message that policymakers should be aware of the distributive consequences of investments in tertiary education. Beyond this, the results of splitting education by levels are quite clear. Upper primary education enrollments correlate with subsequent improvements in income distribution (the coefficients are relative to the omitted category of primary education enrollment). Secondary and tertiary enrollments correlate with subsequent deterioration in the income distribution, whether measured according to a national or a state-relative definition. There is a general descending pattern

Table 4.28. Analyzing Levels of Education

	I	II	III	IV
Period **Dependent variable**	**1989–98** **growth**	**1989–98** **income growth** **of poor**	**1989–98** **quality**	**1989–98** **"relative"** **equality**
Coefficients				
Secondary	–0.018	–0.031	0.241**	0.219
	(0.46)	(0.68)	(1.97)	(1.39)
High school	–0.023	–0.0059	–0.391**	–0.291**
	(0.36)	(0.08)	(3.49)	(2.39)
College	0.160	–0.143	–0.396*	–0.278
	(0.80)	(0.83)	(1.68)	(1.11)
…Other coefficients not reported				
R^2 (OLS-FD)	0.47	0.42	0.18	0.17
Number of observations	1,845	1,845	1,685	1,685
Number of groups	190	190	171	171
Mean no. of periods	9.7	9.8	9.9	9.9

*Coefficients are statistically significant at the 10 percent level.
**Coefficients are statistically significant at the 5 percent level.

from positive toward negative distributive impacts as one ascends through the levels, as one would expect.

Location and International Trade. Three of the hypotheses enumerated at the beginning of the section concern trade, migration, and geographical location (climate, latitude, and altitude). Since these variables are fixed in time, or have been for practical purposes since data are only available for certain years, the estimation strategy of the previous section, which relies on taking first differences of the data in consecutive years to control for all state-fixed effects (simultaneously ruling out identifying them), is inapplicable. However, following the approach of Holtz-Eakin, Newey, and Rosen (1988), a workable alternative is at hand. The main element is allowing state-fixed effects to be nonstationary (time-variant) so that the model is generalized to encompass the state-fixed effects model as a testable restricted form. This more general specification is known as quasi-first-difference (QFD) estimation. If the restricted stationary fixed effects form is rejected (as it is in our data), this allows the effects of other time-invariant variables (such as geographical location) to be identified by the estimation.

Table 4.29 gives the coefficients from a QFD specification including location and trade variables. There is evidence of trade and climate effects in general income growth, but not among the poor. Most noticeable is distance-from-the-sea's negative effect on income growth, an effect that became more marked in the 1990s. We interpret this as possibly attributable to international trade, suggesting trade's growing importance for income growth in Brazil. The result is intuitive given the lowering of tariff barriers in the early 1990s. However, the incomes of the poor show no sensitivity to trade access, lending support to the view that trade opening has not helped the poor. The result is confirmed in the inequality regressions (columns III and VI): the positive coefficient on distance in our interpretation implies that access to markets has increased inequality in Brazilian household income, with the effect larger and more significant in the 1990s. Of course, distance from the sea may be capturing factors in Brazil other than access to foreign markets, given the proximity of all the main metropolitan centers to the coast.

Table 4.29. QFD Growth Equation Coefficients
(absolute t-statistics)

	I	II	III	IV	V	VI
Period	**1984–98**	**1984–98**	**1984–98**	**1989–98**	**1989–98**	**1989–98**
Dependent variable	**growth**	**inc. growth of poor**	**growth equality**	**growth**	**inc. growth of poor**	**growth equality**
Coefficients						
Temperature	0.116	0.0157	–0.0142	–0.0048	–0.0231	–0.0470
	(0.66)	(0.94)	(0.85)	(0.16)	(0.86)	(1.60)
Rain	–0.0017	0.0018	0.0080	0.0545*	0.0645*	0.0074
	(0.10)	(0.10)	(0.48)	(1.66)	(1.71)	(0.17)
Latitude	0.0133	0.0006	–0.0043	0.038	0.0455	0.0044
	(0.83)	(0.03)	(0.31)	(1.31)	(1.57)	(0.15)
Altitude	0.0005	0.0010	–0.0073	0.0057	–0.0033	–0.0165*
	(0.10)	(0.21)	(1.39)	(0.74)	(0.48)	(1.82)
Distance	–0.0072*	–0.0016	0.0103**	–0.0187**	0.0001	0.0281**
from the sea	(1.77)	(0.41)	(2.61)	(2.96)	(0.01)	(3.53)
Number of observations	2,550	2,550	2,550	1,695	1,695	1,695
Number of groups	171	171	171	171	171	171
Mean no. of periods	14.9	14.9	14.9	9.9	9.9	9.9

*Coefficients are statistically significant at the 10 percent level.
**Coefficients are statistically significant at the 5 percent level.

Rainfall has a weak effect on income in the 1990s (column IV) in the direction one might expect (higher rainfall raises income growth). This effect is approximately equal for poor and nonpoor alike (columns IV and V), reflected in the absence of any relation between rainfall and inequality (column VI). Turning this around suggests that low rainfall hurts the poor proportionately (or even a bit more than average if one uses the point estimates, although the difference between them is not statistically significant), justifying public interventions in times of drought in the interest of equity. We will not overemphasize this analysis since sophisticated econometrics are probably not required to reach this conclusion.

Migration. Estimating the effect of migration in these data suffers from two problems. First, migration figures have only been calculated for two years, so much of the time variation in this variable remains unobserved. Second, it is therefore impossible to structure a convincing specification that sorts out the very severe problems of endogeneity that this variable poses. Migration is clearly a choice made in response to incentives, including the relative expected economic opportunities offered by point of departure and destination. This induces correlation between future economic activity and inward migration, even in the absence of a causal effect running from migration to subsequent growth.

We nevertheless ran one specification of the regressions including the migration variable, and found that migration into a state is not correlated with subsequent growth in average household per capita income in the period.

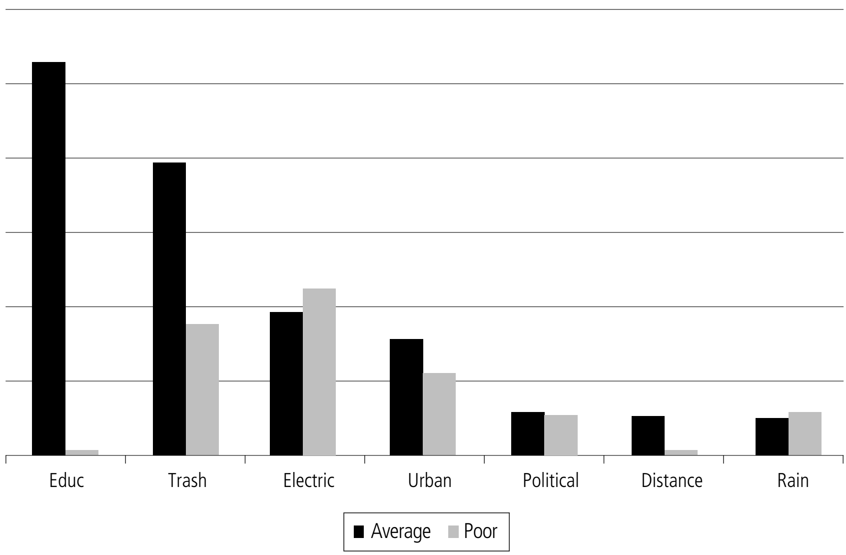
Conclusions

Household data reveal that, within 1980–2000, significant convergence has occurred between the poorer and richer Brazilian states only since the Real Plan stabilization and that much of the convergence pattern is due to the pro-poor impact of eradicating inflation. International evidence suggests that any growth strategy that jeopardizes this central achievement is likely to fail. This section suggests, furthermore, that it would likely hurt the poor the most.

Comparing the income growth of the average household with that of the average *poor* household reveals that the poor do benefit from economic growth, although their incomes do not rise proportionally with those of everyone else. That is, a general income rise of 1 percent corresponds to an income gain of less than 1 percent for the poor. Moreover, this effect tends to increase as growth increases, implying that higher growth has tended to raise income inequality among households. These effects were attenuated in the late 1990s, however.

Panel regression analysis of differences in household income growth by state and age cohort reveals the primacy of education as an influence on income growth in Brazil. However, the effect of *average* education on the income growth of the poor is nil; improvements in basic education among the poor have not (yet) significantly affected income growth. Further analysis suggests that investments in basic education and lower secondary education are central both to increasing income growth and to attacking inequality.

Figure 4.12. Representation of Effects of RHS Variables
(response of income growth to a one-standard-deviation improvement in the variable)



Finally, other factors are important growth determinants for household income. Local infrastructure (e.g., electrification, trash collection) plays a significant role in subsequent income growth. And international trade and political stability also boost income growth. These factors vary in their importance to the poor relative to the average. Electrification seems to have been particularly important for the income growth of the poor.

Policy Conclusions

Looking Back: Resolving the Paradox of the Economic Miracle

Brazil was one of the world's fastest-growing economies in the 20th century despite a mix of policies frowned upon by orthodox modern economics. However, a closer look at events and econometrics suggests that Brazil's achievements were less paradoxical than this broad statement initially suggests.

First, the stage for economic growth was primed in 1964 by a subset of policies that were in fact remarkably orthodox when set against the economic debates alive at the time. Despite benign external conditions—in particular, favorable terms of trade and low import growth—that had benefited the centrally planned efforts of the 1950s (notably Kubitschek's Plano de Metas), domestic economic fundamentals deteriorated substantially with the large increase in the public deficit and its financing through monetary expansion, bringing inflation to a new historical threshold. By 1963 investment was stagnant, the public deficit totaled half of fiscal revenues, and inflation was accelerating. The new military government adopted a stabilization program to lower inflation, reduce the public deficit, and correct relative prices. The exchange rate was devalued and a tax reform implemented, greatly reducing tax distortions, raising revenues dramatically, and improving the current account. The government also implemented monetary and capital market reforms with the establishment of an indexation mechanism. Despite its later shortcomings, this restored domestic and foreign confidence in long-term contracts in capital and credit markets. Lastly, the government established a crawling-peg exchange rate regime with small devaluations at randomly determined intervals.

After a time, investment reacted positively to the more stable environment, increasing rapidly. By 1967, the economy contained a large idle capacity, which was to prove key in the successful economic performance that ensued. Thus despite a high degree of central planning in the economy, the macroeconomic management that paved the way for Brazil's economic miracle of the late 1960s and early 1970s was in fact fairly orthodox.

The second half of the explanation is less optimistic but no less orthodox. Brazil's continued growth after the first oil shock of 1973 was simply unsustainable. Repressed inflation and the need for structural adjustment in the foreign accounts were legacies of the miracle years. Yet the government opted to sustain the pace of economic growth, making inflation a secondary priority and leaving the external accounts as an adjustment variable, partly from belief that the oil shock would be transitory. The substantial liquidity in international capital markets, created by the recycling of petrodollars, provided the means to sustain this course temporarily, although Brazil's external debt had already begun to rise. Again, in the mid-1970s, favorable shifts in terms of trade helped Brazil stick to its guns, but Brazilian export quantities remained virtually constant. In the late 1970s, Brazil's current account deficit widened again, and its rapidly growing external debt, largely contracted at floating interest rates, greased the slope for the lost decade of the 1980s.

As other studies have also shown, physical capital accumulation and TFP growth explain most of the growth dynamics of the Brazilian economy since 1930. The higher the value of the capital elasticity of output used for decomposing growth, the higher the contribution of capital and the lower the contribution of TFP. However, TFP growth seems to have been systematically associated with growth in the stock of machinery and equipment, suggesting that some TFP growth was gained through capital-embodied technological progress.

This suggests another reason for the eventual faltering of Brazil's high growth performance in the 1970s. Part of the government response to external imbalances early in the decade had been to increase import barriers on capital goods. The subsequent drop in capital-good imports created ripple negative effects by decreasing embodied technological progress.

A final legacy of the macroeconomic imbalances inherited from the 1980s has been the dramatic decline in Brazilian infrastructure investment, which had been undertaken primarily under the aegis of the state until the 1990s. Fiscal constraints precluded a concerted campaign of public investment in the 1990s, while residual macroeconomic uncertainty, scarce credit, and a regulatory regime that has until recently still been in its formative stages (e.g., the energy sector) limited willingness and the ability of the private sector to step into the breach.

Looking Forward: Policies for the Next Century

In contrast to the broad pattern since 1930, macroeconomic growth accounting exercises suggest that the acceleration of GDP expansion after price stability in 1994 was entirely due to higher TFP growth. Under most assumptions, TFP growth was higher in 1994–2000 than at any time since 1930. Indeed, the reason why low inflation and the 1990s market reforms have failed to bring output growth back to pre-1980 levels has been the failure of those reforms to generate factor accumulation, with the contributions of both labor and capital to output growth actually declining in comparison to 1981–93. This TFP recovery proves slightly elusive in firm-level data, where TFP growth in the 1990s seems somewhat anemic. The broad pattern of TFP decline through the 1980s and recovery in the 1990s is nonetheless present.

More helpful for policy formulation are the differential patterns of TFP growth observed across firms of differing characteristics. Less-technological sectors—food, textiles, leather, and nonmetallic minerals—showed the worst performance and actually declined in productivity during the 1990s, while more-technological sectors—autos and auto parts, and electrical equipment—were more dynamic. In addition, the industrial composition of the manufacturing sector in the North and Northeast led to lower TFP growth in these regions relative to the South and Southeast.

Trade opening has had a positive effect on industrial productivity and may have helped raise average TFP by about 6 percent. Market penetration by foreign competitors raised the level of TFP, though export orientation does not raise TFP in the Brazilian data; indeed this relationship is negative. Other findings suggest the importance of technological innovation: higher shares of IT in physical capital raised both TFP and its growth rate. Complementing this result, firms employing more skilled labor (expressed as a higher white-to-blue-collar ratio) showed faster TFP growth, suggesting that Brazilian human capital investments contribute to TFP growth. Foreign machinery, on the other hand, had no significant effect, calling into question its role as a conduit of embodied technological change in recent Brazilian growth. Given evidence from firms in other countries about the importance of international knowledge flows, this result raises concern that Brazil's integration into international production is not generating its full potential benefits, perhaps because of a bias toward regional trade or owing to technology transfer impediments. Finally, new firms possessed higher and faster-growing TFP, suggesting that measures to ease their entry could spur future productivity gains for Brazil.

The future importance of knowledge flows and the vibrancy of new entrants must be seen in the context of Brazil's present business environment. The directed credit schemes that reflect the centrally planned approach of Brazil's past, a heavy regulatory burden involving three levels of government (e.g., rules for business licenses and site development), cascading taxes, pervasive labor regulations, controls on foreign licensing and technology transfer, and a slow process of intellectual property protection are all candidates for public scrutiny and reform given the empirical evidence presented here.

Household evidence buttresses what has already been suggested by firm-level data about the need for human capital investments in Brazil. Macroeconomic analysis suggests that human capital accumulation has yet to become the driver of the country's economic growth. In fact Brazil's human capital levels, particularly education indicators, still lag behind the region's. Yet in the 1990s, education emerged in household data as the strongest determinant of income growth.

Indeed the expansion of basic education, in particular lower secondary schooling, is the single most powerful tool at the government's disposal for improving the distribution of gains from economic growth among the population. In this regard, the household data contain another important finding. It shines a spotlight on the fundamental role the Real Plan played in improving the incidence of income growth among the poor by ending inflation. This is a key policy conclusion: any return to the inflationary environment of the past would above all hurt Brazil's poor. By continuing these two basic policies—expanding high-quality basic education and keeping inflation low—Brazil can avoid the pitfalls of the growth-inequality trade-off that the data suggest it has faced in the past.

Clearly a return to the policies that Brazil pursued in the 1960s and 1970s is neither feasible nor desirable. Scrutiny of Brazil's most successful period of economic growth suggests that macroeconomic fundamentals were not ignored in laying the foundation for growth, and that when they eventually were, this was not without consequences. Attention to what the macroeconomic and microeconomic data are telling us today suggests that trade, enterprise, innovation, knowledge flows, and human capital will be the primary drivers of Brazil's growth in the next century.

Appendix 4.A

Vector Error Correction Model

$$Y = AK^{\alpha}L^{1-\alpha}$$

Vector Error Correction Estimates

Sample (adjusted): 1933–99
Included observations: 67 after adjusting endpoints
Standard errors in ( ) & *t*-statistics in [ ]

Cointegrating Eq	CointEq1	
LY(–1)	1.000000	
LKL(–1)	–0.709671 (0.01923) [–36.8992]	
C	6.139549 (0.20220) [30.3638]	
Error Correction	**D(LY)**	**D(LKL)**
CointEq1	–0.230796 (0.05925) [–3.89541]	–0.019307 (0.02339) [–0.82529]
D(LY(–1))	0.267711 (0.11714) [2.28537]	0.109657 (0.04625) [2.37081]
D(LY(–2))	0.394475 (0.11707) [3.36969]	0.106968 (0.04622) [2.31418]
D(LKL(–1))	0.150799 (0.35487) [0.42495]	0.866719 (0.14012) [6.18568]

D(LKL(–2))	–0.048860	–0.057031
	(0.31686)	(0.12511)
	[–0.15420]	[–0.45584]
D81	–0.090956	–0.015216
	(0.03246)	(0.01282)
	[–2.80200]	[–1.18719]
R^2	0.342000	0.835520
Adj. R^2	0.288065	0.822038
Sum sq. resids	0.062505	0.009745
S.E. equation	0.032011	0.012639
F-statistic	6.341031	61.97322
Log likelihood	138.6672	200.9276
Akaike AIC	–3.960214	–5.818736
Schwarz SC	–3.762779	–5.621301
Mean dependent	0.030122	0.038607
S.D. dependent	0.037938	0.029961
Determinant residual covariance		1.34E-07
Log likelihood		346.2347
Log likelihood (d.f. adjusted)		339.9488
Akaike information criteria		–9.699964
Schwarz criteria		–9.206377

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Chapter 5

On the Determinants of Chilean Economic Growth

Rómulo A. Chumacero and J. Rodrigo Fuentes[1]

Since the mid-1980s, Chile's economic performance has been nothing short of impressive compared to the other economies of Latin America and most countries in the world. Yet this was not always so.

In the 1960s and 1970s Chile's performance was far from outstanding (Table 5.1). In fact, its per capita GDP growth was far below the average of East Asia, the OECD countries, and the global economy. When compared with that of other Latin American countries, the Chilean economy was about average in the 1960s and below average in the 1970s and only pulled clearly ahead in the next two decades. That positive difference in performance is even larger if we consider the period 1984–98 (Figure 5.1).[2]

Figures 5.2 and 5.3 show that, depending on the period, Chile experienced differences that were statistically significant compared to other Latin American countries, not only in average per capita GDP growth, but also in its volatility. The informal evidence depicted in these figures shows that the Chilean experience is influential in the sense that without it valuable information about the region's economic performance would be omitted.

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[2] Figure 5.1 is derived from the latest Penn World Table (for details see Summers and Heston, 1991).

Table 5.1. Average Annual Per Capita GDP Growth (1960–95)

	1960–70	1970-80	1980–90	1990–95	1960–95
Chile	2.3	0.8	1.1	5.4	1.9
Latin America (21)	2.3	2.3	–1.5	1.4	1.1
Sub-Saharan Africa (17)	2.1	1.1	–0.8	–1.9	0.5
East Asia	4.7	6.0	4.6	4.1	5.0
OECD (22)	4.3	2.5	2.1	1.1	2.7
World (81)	3.2	2.6	0.6	1.1	2.0

Source: De Gregorio and Lee (this volume).

Chile's experience over time significantly diverged from that of the other countries in its cohort (at least in degree and often in kind). Before the oil crisis of the early 1970s, its economic performance (in terms of both growth rate and volatility) was close to the Latin American average. Between the oil crisis and the debt crisis, Chile displayed atypical vulnerability, given the low growth and high volatility exhibited during those crises

Figure 5.1. Evolution of (Log) Per Capita GDP in 10 Latin American Countries

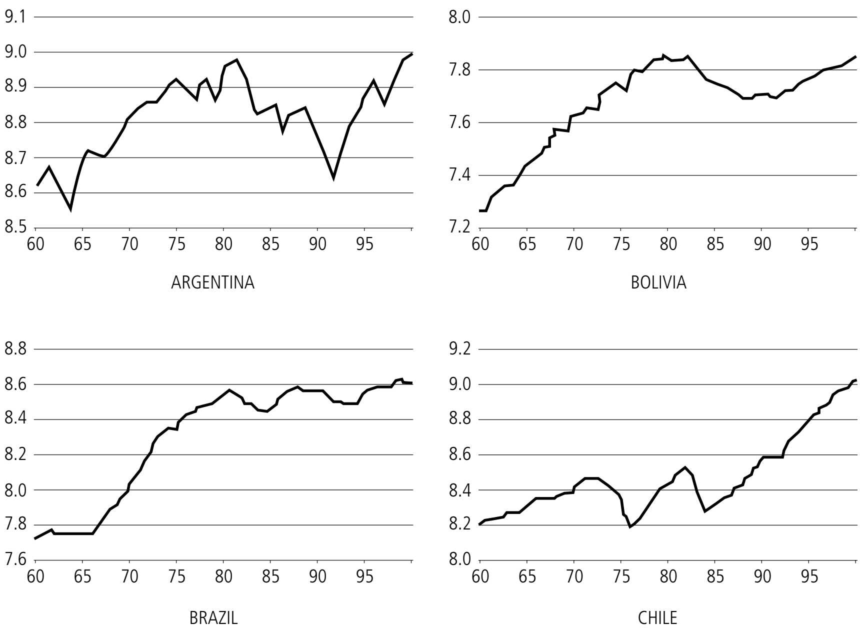
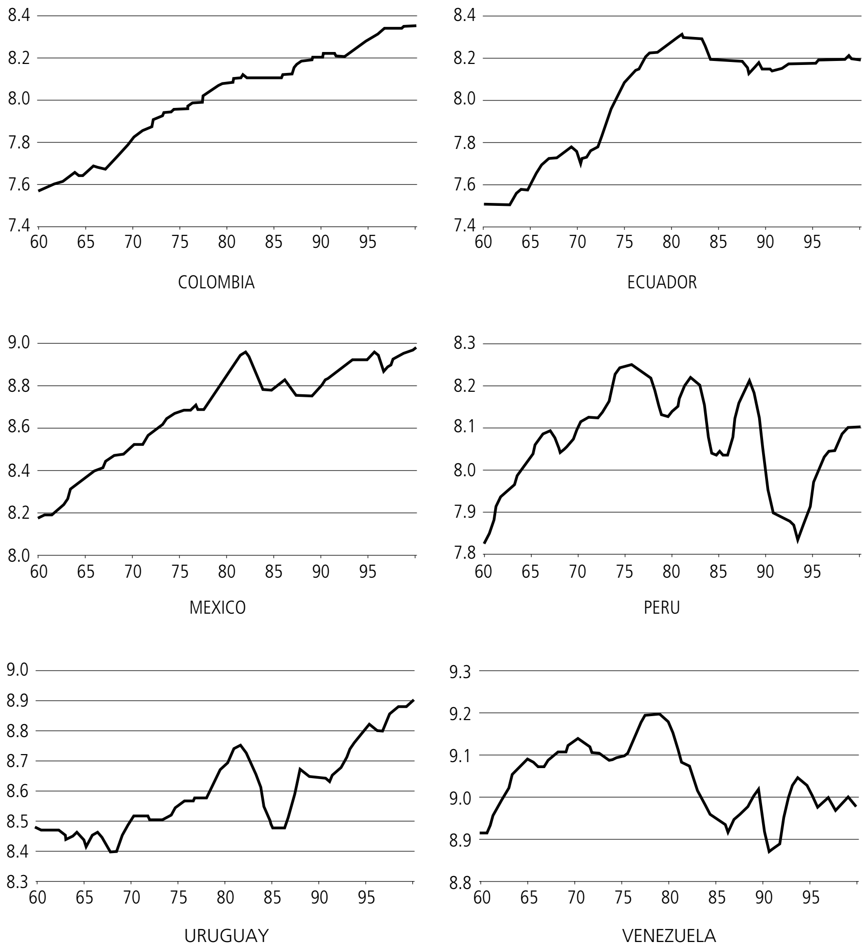


Figure 5.1. Evolution of (Log) Per Capita GDP in 10 Latin American Countries
(continued)



(Chile's figures lie outside the 95 percent confidence intervals). However, the speed of its recovery afterwards was unmatched. Chile not only generated the region's highest growth rates but did so while exhibiting a level of volatility that was not statistically different from the regional average.

A usual candidate for explaining the performance of an economy is its investment rate. However, the correlation between per capita GDP growth

Figure 5.2. Deviations from Latin American Average Growth

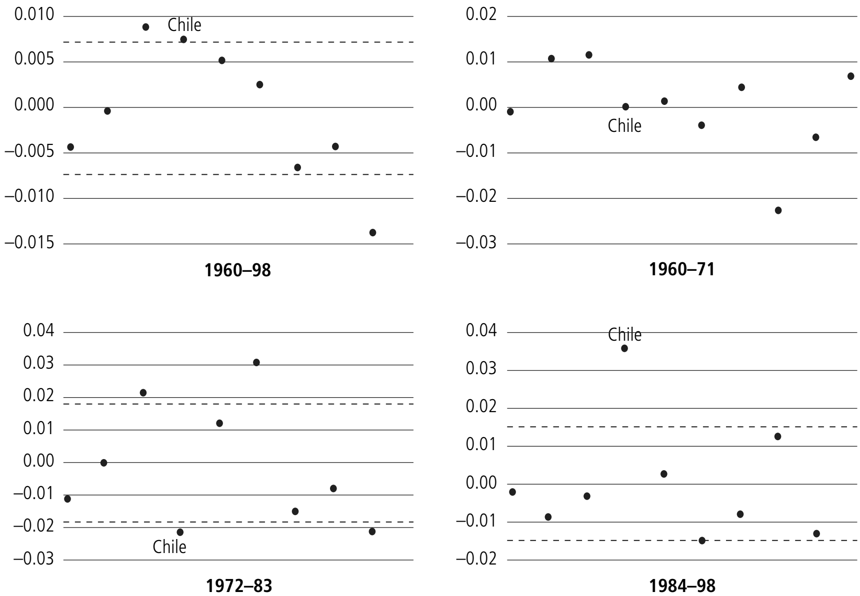
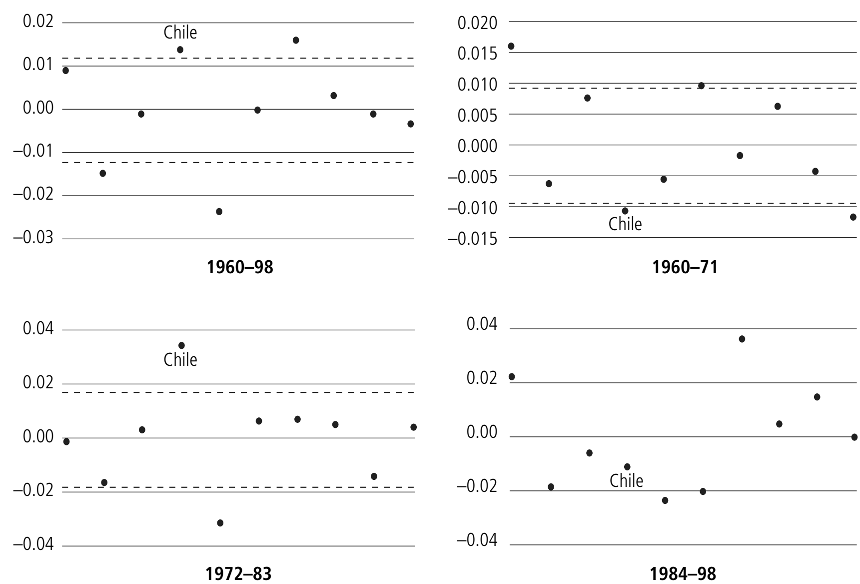


Figure 5.3. Deviations from Latin America's Average Growth Volatility

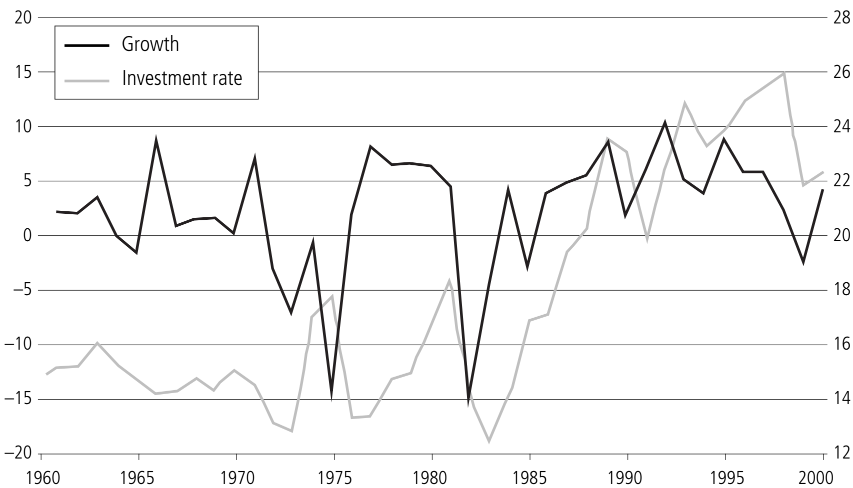


and the investment rate is, at most, 0.35. Furthermore, while the investment rate between 1960 and 1973 steadily declined, it rose from 1984 until 1998 (Figure 5.4). It could be argued that while the contribution of capital to growth was very important during the first period, in the second, the recovery from the deep recession of the early 1980s caused the growth rate to lead the economy to higher investment rates. Anecdotal (statistical) evidence is readily available, given that Granger causality tests suggest that both the level and first difference of per capita GDP preceded the investment rate from 1984–2000, while there is no discernible direction of statistical causation from 1960–73.

Thus having formal measures to evaluate a range of determinants for such a heterogeneous performance during the two periods would be instructive. In particular, one would like to know which characteristics made economic performance so average through the 1960s, so sensitive to the two major international crises in the early 1970s and early 1980s, and so stimulative to growth rates and dampening to volatility from the mid-1980s onward.

Studying Chile's economic performance is interesting not only because of its remarkable differences in growth rates and volatility compared

Figure 5.4. Per Capita GDP Growth and Investment Rate



to other countries in the region, but also because it has experienced major swings in institutional arrangements and economic policies that provide a rich contextual history for evaluating the data.

This chapter provides a qualitative and quantitative evaluation of the main factors behind Chilean growth. The first section looks at the history for the period under analysis.

The next section uses a growth accounting exercise to approximate total factor productivity (TFP). The results from that exercise are then used to conduct a multivariate time series analysis that includes several measures of economic distortions to assess which are important determinants (or consequences) of Chile's economic performance. Features found to be relevant are then incorporated into a model that attempts to quantify the growth effects of several shocks. Finally, the last section summarizes the main analytic conclusions and draws policy implications.

Historical Overview of the Chilean Economy

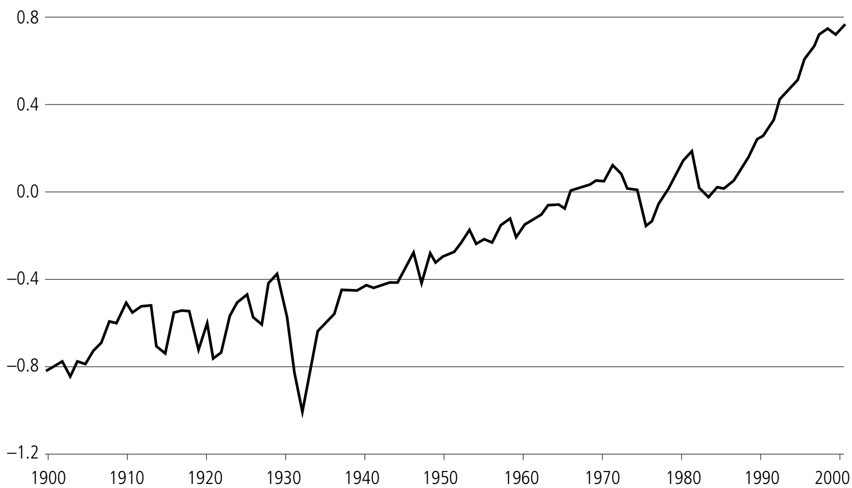
One purpose of this chapter is to better understand how economic policy has impacted Chilean growth. This section presents a brief overview of the main economic policies since Chile became a nation. Much of this can be summarized from Lüders (1998), which provides a long-term analysis (1820–1995) of the Chilean economy and compares it to other developing and developed countries. The primary focus is on the last 40 years, for which more reliable information is available. Figure 5.5 tracks the last century's events.

Chile achieved political independence from Spain in 1810. According to Lüders, the first period of Chilean economic history can be characterized as liberal, with two distinct phases demarcated by the Pacific War. Between 1820 and 1878, Chile grew faster than the other Latin American countries (1.39 percent versus 0.1 percent), while in the second phase, 1880–1929, the growth rate was about average. Lüders highlights the positive wealth effect that the Pacific War had on the Chilean economy but notes that the annexation of nitrate and silver mines may have induced two negative effects: a very rapid increase in government expenditures (more rent-seeking activities) and a "Dutch disease" phenomenon that cut off some traditional activities. During the second phase of the liberal economy that followed the war, the political climate was unstable, marked by a civil war in 1891 and military takeovers in 1924 and 1927–32.

The Great Depression ushered in a new economic period, characterized by a strategy of import substitution, mainly in reaction to the sudden and precipitous drop in the price of nitrate, a bedrock of the previous period. As the price and sales of most Chilean export products plunged after 1929, the national economy contracted severely. According to Lüders the Chilean economy was among the hardest hit during the Great Depression (per capita GDP fell by 47 percent and exports by 79 percent).

Unable to affect the global climate, economic policy turned inward, a reaction typical of the times. Government took an active role, implementing industrial policies and creating state-owned enterprises. Manufacturing was protected with high tariffs, nontariff barriers (NTBs), and multiple exchange rates. These trends took root and expanded between 1940 and 1970, interrupted only briefly by a weak and failed attempt to reverse course between 1959 and 1961.

Figure 5.5. Log of Per Capita GDP (1900–2000)



Sources: Braun et al. (2000) and Díaz, Lüders, and Wagner (1999) for the period up to 1995 and the official growth rates from the Central Bank of Chile for the period 1996–2000.

In 1970, a newly elected socialist government took inward-oriented economic policy and government intervention to a new level. From that year until 1973, Chile could accurately be described as virtually a closed economy. Economic policy was characterized by strong government interventions; price, interest rate and exchange rate controls; high (tariff and nontariff) barriers to trade and to international capital flows; and a very high inflation rate. The government also expropriated a significant number of private companies.

After the military coup of 1973, movement began toward a market-oriented economy. Among the most important changes in policy were a focus on price liberalizations, an aggressive opening of the economy to trade and international capital flows, a reduction of the size of government, and privatizations. Furthermore, Chile introduced pioneering reforms to its social security system, financial markets, and health care system. One of the most profound changes was the trade reform that eliminated all NTBs and reduced tariffs to 10 percent across the board (except for automobiles).

All these changes were implemented despite major international crises. The oil crisis hit when the economy was starting the reforms. The sum of the external shock and the reform severely impacted GDP.

The debt crisis of the early 1980s was set off by a negative external shock (an increase in the international interest rate and a deterioration in terms of trade) coupled with internal policy mistakes. A fixed exchange rate policy, combined with a very low convergence of domestic to international inflation, induced a large real appreciation of the peso with respect to the dollar, creating a large current account deficit. Given the external situation, the foreign sector was unwilling to finance the current account deficit, while at the same time, the domestic financial system had structural problems, lacking effective regulation, supervision, and expertise.[3] As a result, the Chilean economy confronted a two-headed crisis (external and financial).

Hard on the heels of trade reform, the real exchange rate appreciation of that period constituted a second shock for the trade sector, induc-

[3] See Fuentes and Maquieira (2000) and the references therein.

ing several bankruptcies and forcing firms to try to increase productivity in order to survive. In fact, the manufacturing sector experienced important reallocations of resources coupled with productivity increases (Fuentes, 1995; Alvarez and Fuentes, 2001).[4] In 1982 the peso was devalued, and tariffs started climbing until 1985, reaching a peak of 35 percent across the board before declining until 1991.

Finally, after the return of democracy in 1990, the major economic reforms formulated in the 1980s were left virtually intact. In fact the newly appointed government reduced tariffs even further in 1991, from 15 to 11 percent, and negotiated free trade agreements with Mexico, Colombia, Venezuela, Canada, Mercosur, the European Union, South Korea, and the United States. These agreements reduced the average tariff paid on imported products. Recently the tariff structure has been reduced even more (from 11 to 8 percent) for countries that are nonmembers of free trade agreements.

This brief overview can be summarized by the evolution of per capita GDP in Figure 5.5. It uses data from Braun et al. (2000) and Díaz, Lüders, and Wagner (1999) for the period up to 1995 and the official growth rates from the Central Bank of Chile for the period 1996–2000.

Total Factor Productivity Analysis

This section derives several estimates of TFP, which are later used to uncover those factors driving the growth process.

Data

Given the available data and their degree of reliability, we analyze the period 1960–2000 using National Accounts records. Capital stock was estimated using the perpetual inventory system from 1940.[5] The data on labor

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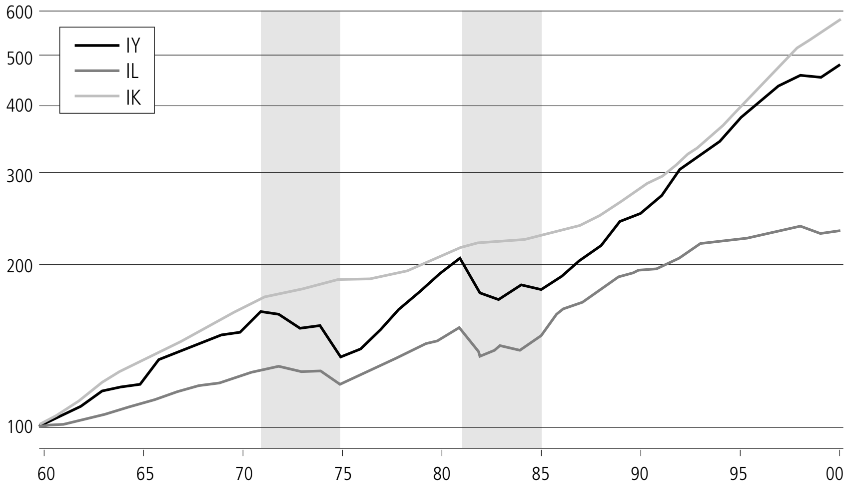
[4] Fuentes (1995) shows that during the trade and market reform period (1975–82) there were substantial increases in the productivity of different manufacturing sectors. As a pattern across sectors could not be found, this feature is consistent with the idea of a "mushroom" process.

[5] We thank Herman Bennett for providing this series.

Figure 5.6. Evolution of GDP, Labor, and Capital (1960–2000)



Note: Index 1960 = 100, log scaling.

correspond to the number of employed people each year and are obtained from the National Bureau of Statistics (INE).

Figure 5.6 shows the evolution of GDP, capital stock, and labor for the 1960–2000 period (expressed as indexes). As can be seen, capital stock grew faster than labor and GDP over the whole sample. Five periods are clearly distinguishable: three of rapid growth and two severe recessions.[6] In the first growth period, GDP expansion was accompanied by a faster increase in capital stock and a smooth upward trend in labor. After the recession, in the mid-1970s, the economy grew very fast, with a relatively slow increase in capital and labor until the onset of the debt crisis. This profound recession caused the unemployment rate to spike. Starting in the mid-1980s the economy bounced back, with a quick recovery in employment followed by a later pickup in the capital growth rate.

[6] The economy entered a short recession in the last quarter of 1998, recovering in 2000. In parts of our analysis we will assume that the third expansionary period ends in 1998.

Methodology

Using the databases cited earlier, one can estimate TFP growth. A key to understanding the contribution of productivity is the measurement of production factors and their change in quality over time. Two estimates of TFP growth will be provided: one using the raw capital and labor data, and the other correcting labor with a quality index.

Input Quality

Better assessment of the growth process in Latin America has been facilitated by improved factor quality (Elías, 1992). One usual way to adjust raw data is by using a labor and capital augmenting correction. For labor we used the estimate made by Roldós (1997), which considers that there are different types of labor (L_j), with wages (w_j), such that the quality correction becomes

$$\sum_{j=1}^{n} \frac{w_j L_j}{wL}. \tag{5.1}$$

Figure 5.7 shows the evolution of this index over time. We compare it with an estimation of human capital stock found in Braun et al. (2000), in which the authors express the educational level of the labor force in tertiary education equivalence using the relationship between market wages. The correlation between both variables is 0.98.

Roldós (1997) also provides an index of quality for the capital stock. The construction of this index hinges on relative rental rates of different types of capital. As this information is unavailable, the author estimates the rate using the market price of investment goods. Figure 5.8 shows the evolution of this index, which contains several disturbing features. In particular it states that the quality of capital goods in 1995 was about the same as in 1960. Furthermore, the continuous decline in capital quality during the 1960s is difficult to explain. For these reasons, we chose not to use this variable.

Figure 5.7. Index of Labor Quality (1960–2000)

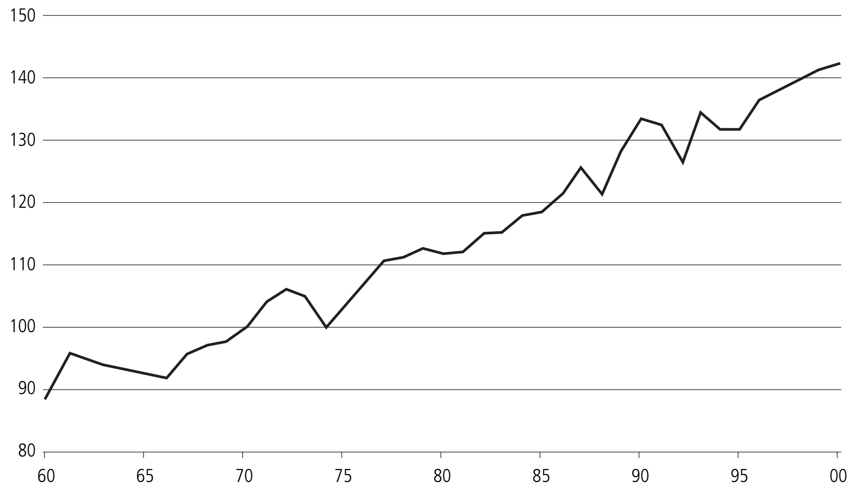
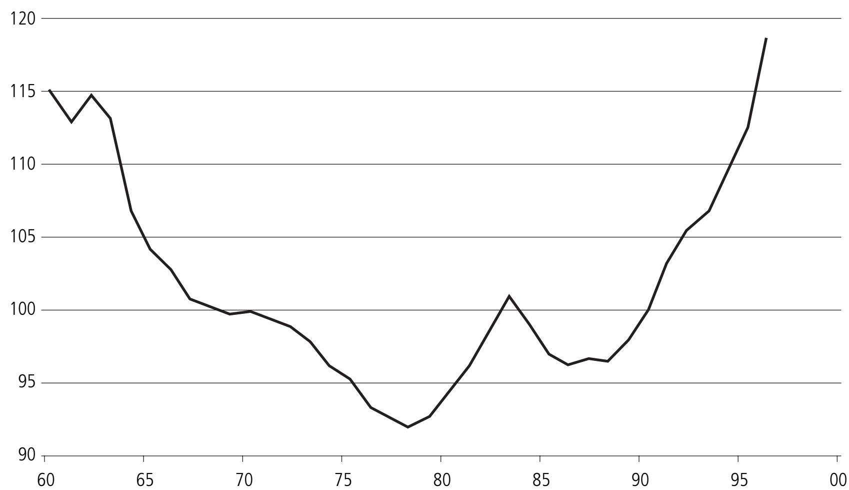


Figure 5.8. Index of Capital Stock Quality (1960–2000)

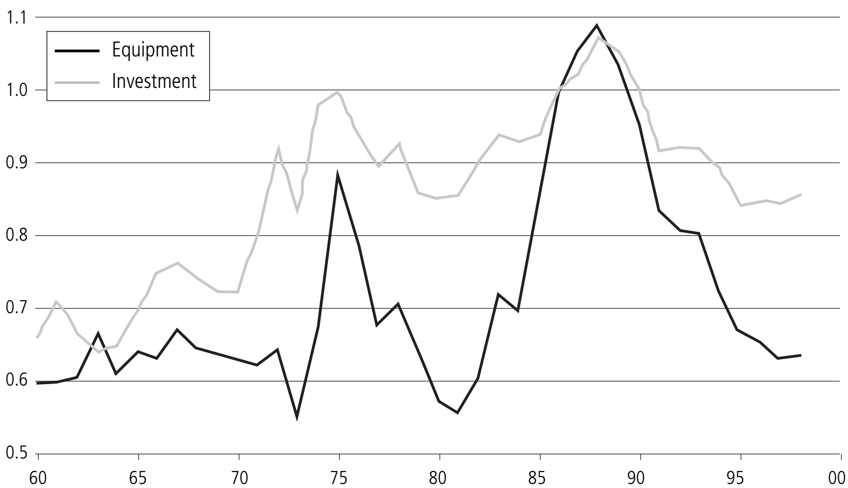


Greenwood and Jovanovic (2000) provide another view of improved quality in capital stock. They associate quality with the evolution of the relative price of investment in terms of consumption; when this relative price decreases, the quality of capital goods rises. There are at least two problems with this interpretation. First, at the aggregate level (even though we separated equipment from structure), there are no permanent decreases in the relative price of equipment. If we consider the case of computers, for example, we can expect a continuous decrease in their relative prices; but when one considers different types of equipment, this may not be the case. For instance, when equipment of higher quality appears in the market, the producing firm may exploit, for a while, monopoly rents in order to pay for the R&D costs (as in the quality-ladder-type models cited in Grossman and Helpman, 1991), causing the equipment price to actually rise.

Second, in linear technology models of endogenous growth, a decrease in the price of an investment good will increase the capital accumulation and ultimately the rate of growth. Thus quality should rise when an economy opens to trade and starts importing capital goods at a lower price (Jones and Manuelli, 1990).

Figure 5.9 shows the evolution of the relative prices of equipment goods and investment goods with respect to consumption goods. Even though they seem to follow the evolution of the real exchange rate (rather

Figure 5.9. Prices of Equipment and Investment Goods Relative to Consumption Goods



than being good estimates of the quality of capital), we will assess the impact of these relative prices on TFP in the next section.

TFP Growth Measures and Capital Share Estimates

Given the considerations discussed above, we analyze two different formulations for TFP. The first does not consider any correction for changes in quality of factors, and the second includes a correction for human capital (TFPH). The equations for TFP growth are

$$T\hat{F}P = \hat{Y} - \alpha\hat{K} - (1-\alpha)\hat{L} \quad (5.2)$$

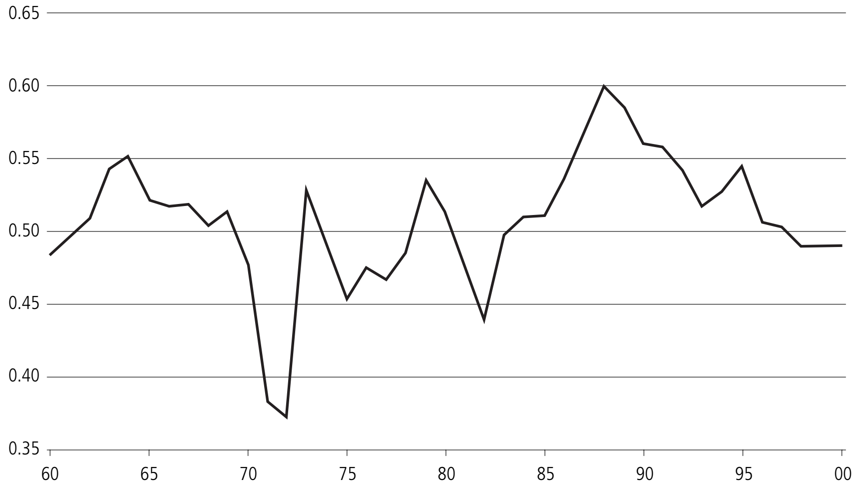
$$T\hat{F}PH = \hat{Y} - \alpha\hat{K} - (1-\alpha)\hat{L} - (1-\alpha)\hat{H}, \quad (5.3)$$

in which H stands for the index of labor quality and $\hat{x}$ denotes the growth rate of variable x. Note that when measured in either way, TFP growth will include both improvements in the quality of capital over time and the technological shock.

The key parameters necessary to estimate TFP are the factor-output elasticities. From the pure growth accounting point of view, estimates of the elasticities are given by the capital and labor shares from the National Accounts records. These shares vary yearly; thus the calculations were made using the average capital and labor shares between two years and the average shares for the entire period ($\alpha = 0.50733$). There is not much difference between these two choices. An alternative estimation used in this exercise is one-third, obtained from the capital share conventionally used in the growth literature. Correlations of the growth rates of estimates of TFP under different assumptions for α are never smaller than 0.98.

Despite the similarities of the TFP measures using a variable or a constant α, there is always a reasonable doubt with respect to which model best describes the data. For instance, a CES function may do a better job than a Cobb-Douglas production function. Figure 5.10 provides informal evidence suggesting that a constant capital-output elasticity is not a bad approximation. In particular, note that the value in 2000 is about the same

Figure 5.10. Capital Share (1960–2000)



as in 1960 and close to the average. However, a regression on a constant shows that the mean is unstable over time. This fact could be reconciled with changes in the input-output matrix from National Accounts (1977 and 1986).

Estimation of TFP Growth

Table 5.2 shows the TFP growth rate for the entire period (1960–2000) and for two subperiods. The first subperiod corresponds to the inward-oriented phase, and the second starts with the trade reform with more than a one-

Table 5.2. Growth Accounting for Periods of Economic Orientation *(in percent)*

Period	GDP growth	TFP (α = 0.507)	TFP (α = 1/3)	TFPH (α = 0.507)	TFPH (α = 1/3)
1961–2000	3.97	0.67	1.07	0.06	0.24
1961–74	3.19	0.06	0.55	–0.37	–0.04
1975–2000	4.40	1.00	1.36	0.29	0.39

Note: H denotes the inclusion of human capital.

Table 5.3. Growth Accounting for Periods of Rapid Growth
(in percent)

Period	GDP growth	TFP (α = 0.507)	TFP (α = 1/3)	TFPH (α = 0.507)	TFPH (α = 1/3)
1960–2000	3.97	0.67	1.07	0.06	0.24
1960–71	4.65	0.91	1.41	0.18	0.42
1975–81	7.32	3.97	3.65	3.27	2.69
1985–98	7.36	2.23	2.72	1.54	1.77

Note: H denotes the inclusion of human capital.

percentage-point difference between periods, mostly accounted for by differences in TFP growth. This feature signals that the elimination of distortions may have significantly increased the efficiency of the economy.

Table 5.3 shows the TFP growth rate for the entire period 1960–2000 and for the periods of rapid growth in the Chilean economy. Two of the booms coincide with the trade liberalization of the 1970s and with the tariff reduction of the late 1980s and early 1990s (after the debt crisis). The performance of TFP growth is rather poor over the whole sample (growing no more than 1.1 percent), while GDP grew an average of 4 percent annually.

As Figure 5.6 made clear, we distinguished three episodes of growth. In evaluating the differences in growth rates of TFP among these periods, one can say that although the growth rate of GDP in the 1975–81 and 1985–98 episodes might be influenced by the recovery from the two deep recessions of the 1970s and the 1980s, in both cases there are significant increases in TFP, a phenomenon not evident in the 1960s.

During the trade reform period (late 1970s), average TFP growth reached its highest value. This period is characterized by important factor reallocations, bankruptcies, and the creation of new firms. In the longest period of continuous growth (1985–98), TFP growth was somewhere between 1.5 and 2.7 percent, more than 1 percent less across the range of results than for 1975–81.

How important was TFP in accounting for GDP growth? This question is important because TFP growth rates were higher in 1975–81 and 1985–98, but so were GDP growth rates. Table 5.4 shows the contribution of factor accumulation (including human capital) and TFP to growth. As

Table 5.4. Growth Accounting for Periods of Rapid Growth

Period	Labor	Human capital	Capital	TFPH
		(α = 0.5073)		
1960–2000	0.27	0.15	0.57	0.01
1960–71	0.25	0.15	0.56	0.04
1975–81	0.29	0.09	0.17	0.45
1985–98	0.25	0.09	0.45	0.21
		(α = 1/3)		
1960–2000	0.36	0.20	0.38	0.06
1960–71	0.33	0.21	0.37	0.09
1975–81	0.39	0.13	0.11	0.37
1985–98	0.33	0.12	0.30	0.25

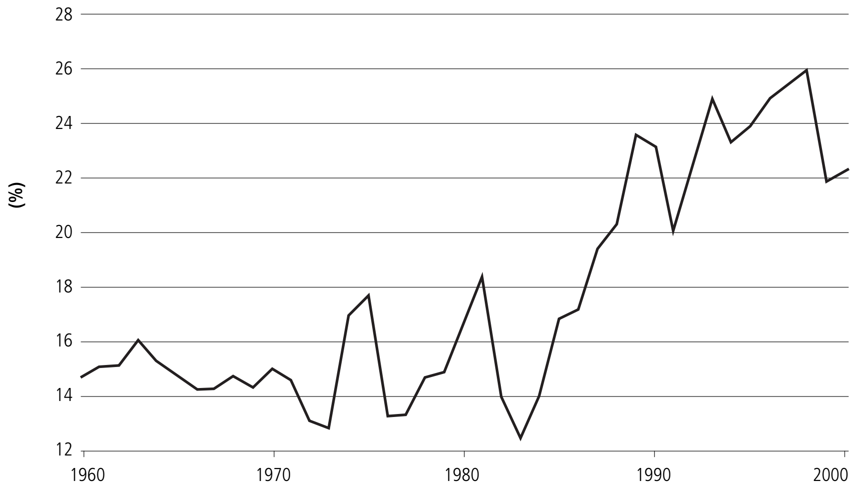
Note: Figures are expressed as ratios of GDP growth.

expected, for the entire period the contribution of TFP was very small after including human capital. The most important contribution to growth was physical capital, which accounts for 57 percent of total GDP expansion.

The growth rate of GDP during the 1960s was characterized by capital accumulation, human capital accumulation, and the lack of total factor productivity growth. As expected, after 1975 the growth rate of TFP played a key role in accounting for growth. However, there is an important difference between the 1975–81 and 1985–98 periods in terms of capital accumulation. The successful period after the debt crisis is accounted for by capital accumulation, which was less robust than in the 1960s but still very important. Furthermore, as the growth literature predicts, trade liberalization and the movement of the Chilean economy towards a free market economy that began in the mid-1970s brought important TFP growth.

However, as mentioned earlier, our TFP growth estimates are also capturing improvements in the quality of capital stock and other factors (such as changes in relative prices and resource allocations). Following the logic of Greenwood and Jovanovic (2000), the reduction in trade restrictions should have increased the average quality of the capital stock, and this should lead to higher TFP growth. This feature is even more important considering that the contribution of capital accumulation was very

Figure 5.11. Investment Rate (1960–2000)



high in the first period of Chilean economic growth (1960–71), while a lower rate of capital accumulation accompanied higher growth rates in the other two periods. This result is in line with economic theory suggesting that an opening to trade and the elimination of distortions increase the average quality of capital and help reallocate capital towards sectors with higher marginal productivity. For convenience, we reproduce the evolution of the investment rate (using current prices) where the efforts from increasing the investment rate in the last period are made evident (Figure 5.11).

It is important to emphasize that the trade reform and the reduction of government interventions in the economy appear to be key when evaluating the performance of the economy in the 1980s and 1990s. However, as mentioned in the historical overview, there were several other reforms that could help account for a higher marginal productivity of capital and for higher growth. For example, this was the case when the banking and capital market reforms combined with a new bankruptcy law.[7] In a

[7] Fuentes and Maquieira (2000) provide an explanation of how these laws affected the recovery of the banking system after the deep banking crisis in the early 1980s.

recent paper, Bergoeing et al. (2001) highlight these reforms as key in explaining the fast recovery of the Chilean economy after the debt crisis.

Another important difference between rapid growth in the 1960s and growth during the other two periods lies in the contribution of human capital. Two caveats accompany this observation: first, since educational attainment has continuously increased over time, it can be argued that enough human capital had already accumulated by the 1970s to make its subsequent marginal contribution modest. Second, the human capital series was measured using relative wages, but changes in these wages may be due to factors other than human capital accumulation. At any rate, other studies show that the contribution of human capital, even when measured differently, is not that dissimilar from the result found here (Schmidt-Hebbel, 1998).

Multivariate Analysis

In the previous section and its subsections we constructed variables that can help one to better understand Chilean economic growth. Specifically, the evolution of total factor productivity and its importance at different stages of recent history were shown. This series can be used to evaluate their main determinants and thus the determinants for growth. Here, we conduct several econometric exercises intended to provide quantitative and qualitative guidelines for a theoretical model to understand the growth dynamics of the Chilean economy.

Factors behind TFP

Having obtained several estimates for TFP, we now consider a set of possible associated variables. Among them are a time series for terms of trade, variables intended to capture the evolution of distortionary policies (such as tariffs and fiscal expenditure over GDP), and relative prices of equipment and investment goods with respect to consumption goods.[8]

[8] The last variables are considered taking into account the derivations of Greenwood and Jovanovic (2000). Thus if either of these relative prices appears significant, we could subtract their participation

Our econometric formulations begin with overparameterized models. After careful reductions and reparameterizations we end up with models for series of TFP (in logs) that can be expressed as

$$f_t = a_0 + a_1 t + a_2 f_{t-1} + a_3 f_{t-2} + a_4 p_t + a_5 p_{t-2} + a_6 T_t + a_7 T_{t-1} + a_8 g_{t-1} + e_t, \quad (5.4)$$

in which a_i are coefficients to be determined, f is the log of each TFP series, p is the log of the relative price of equipment goods with respect to consumption goods, T is the log of terms of trade, and g is the ratio between fiscal expenditures and GDP.

Table 5.5 shows the results of the estimations (only statistically significant variables are included). Given the close association between the measures of TFP, the characteristics and even the coefficients associated with each variable are remarkably similar, finding in all cases that reductions in the relative price of equipment goods with respect to consumption goods, improvements in terms of trade, and reductions in the contribution of government expenditures to GDP are positively associated with our measures of TFP. Furthermore, consistent with results from the previous section, we also find that TFP can be characterized as trend stationary. Thus every transitory shock on the variables included in the regressions would have only transitory effects on the levels of our TFP estimates.

This does not mean that policies are unimportant; it only means that transitory policy shocks affect the level of the series without having permanent effects. As expected, a_4 and a_5, when significant, are negative; if these variables measure the quality of capital, a reduction in the relative price of equipment with respect to consumption goods signals an improvement in the quality of capital stock. In this regard, this variable is intended to capture the exclusion of the adjustment for capital stock quality in our growth accounting exercise as well as possible reductions in distortions.

from the TFP series since, in the spirit of that article, movements of relative prices would be related to the quality of the capital stock and not directly to TFP per se. Nevertheless a case could be made for associating the evolution of these relative prices to modifications in distortionary policies, making these prices a combined effect of increased capital quality and reduced distortions.

Table 5.5. Results of TFP Regressions

	TFP (α = 0.507)	TFP (α = 1/3)	TFPH (α = 0.507)	TFPH (α = 1/3)
a_1	0.008 (0.001)	0.010 (0.004)	0.005 (0.001)	0.006 (0.001)
a_2	0.349 (0.135)			
a_3	–0.269 (0.116)	–0.405 (0.182)	–0.501 (0.155)	–0.377 (0.156)
a_4	–0.220 (0.038)	–0.303 (0.033)	–0.259 (0.032)	–0.283 (0.035)
a_5		–0.141 (0.068)	–0.197 (0.061)	–0.210 (0.065)
a_6	0.083 (0.026)	0.082 (0.038)	0.164 (0.033)	0.116 (0.039)
a_7		0.083 (0.030)		0.072 (0.033)
a_8	–0.571 (0.119)	–0.410 (0.139)	–0.852 (0.113)	–0.576 (0.114)
R^2	0.940	0.963	0.913	0.915
DW	2.199	1.895	2.015	1.858
Q	0.115	0.199	0.241	0.793
Q^2	0.741	0.109	0.159	0.467
JB	0.629	0.572	0.852	0.365
Ra	0.174	0.286	0.081	0.167

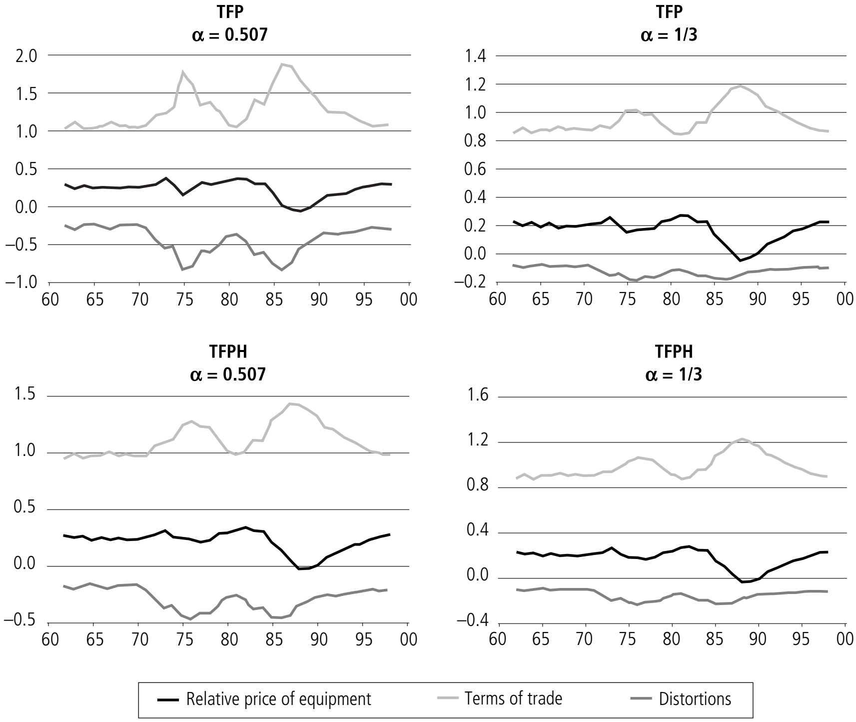
Note: R^2 = Adjusted R^2; DW = Durbin-Watson statistic; Q = Minimum *p*-value of Ljung-Box test for white noise on the residuals; Q^2 = Minimum *p*-value of the Jarque-Bera normality test; JB = Jarque-Bera statistic; Ra = *p*-value of the Ramsey test; standard errors are in parentheses; TFPH indicates the inclusion of human capital.

Also of interest are the positive effect of terms of trade on TFP and the negative and statistically significant effect of the size of government as a fraction of GDP. It may be argued that this last variable cannot be considered as exogenous given that it may have been used to conduct countercyclical policies. We find evidence that g is weakly exogenous to the parameter of interest (in the sense used by Hendry, 1995); thus, conditioning our estimates of TFP on g is a valid econometric practice.

After removing the trend and persistence component, Figure 5.12 presents the contribution of each variable to TFP. We find that almost all of the variation of TFP (excluding the trend component) can be accounted for by the evolution of terms of trade and that the negative effect of our measure of distortions more than offsets the improvements in the quality of the capital stock.

Given that all our estimates of TFP are robustly associated with these three variables, we estimate a simple model for the level of (log) GDP that associates it with them. The impulse-response functions of the innovations

Figure 5.12. Effect on TFP



of these variables on GDP will be used as a metric to compare with the theoretical model developed in the next section.

While simple, our econometric formulation is able to provide well-behaved residuals and successfully passes all of our specification tests. It is given by

$$y_t = b_0 + b_1 t + b_2 y_{t-1} + b_3 p_t + b_4 T_t + b_5 g_t + e_t, \qquad (5.5)$$

in which b_i are coefficients to be determined, y is the log of GDP, and all the other variables are as defined in (5.4).

As Table 5.6 shows, the relative price of equipment with respect to consumption goods and our proxy for distortions are negatively associated with GDP, while improved terms of trade positively affect GDP. Consistent

Table 5.6. Results of TFP Regressions

	y
b_1	0.017 (0.005)
b_2	0.615 (0.106)
b_3	–0.163 (0.064)
b_4	0.107 (0.051)
b_5	–0.634 (0.174)
R^2	0.990
DW	1.817
Q	0.262
Q^2	0.150
JB	0.099
Ra	0.257

Note: R^2 = Adjusted R^2; DW = Durbin-Watson statistic; Q = Minimum p-value of Ljung-Box test for white noise on the residuals; Q^2 = Minimum p-value of the Jarque-Bera normality test; JB = Jarque-Bera statistic; Ra = p-value of the Ramsey test; standard errors are in parentheses.

with our previous findings, we model y as a trend-stationary series; thus all included regressors have only transitory effects over the scale variable. Furthermore, weak exogeneity conditions are satisfied by p, T, and g.

Next, we estimate laws of motion for p, T, and g as univariate time series models. These simple specifications provide good statistical approximations for the processes of each variable and are able to account for most of their dynamic characteristics.[9]

Back to Fundamentals

Chumacero and Fuentes (2002) calibrate a dynamic stochastic general equilibrium model that explicitly introduces the theoretical counterparts of p, T, and g. For completeness, we summarize the model and present their results.

The economy is inhabited by a representative agent that maximizes the expected value of lifetime utility as given by

[9] VAR models were also considered for obtaining the multivariate representation of these variables. Our results do not change significantly if a VAR(1) representation is considered instead of simple univariate representations.

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

with

$$u(c_t, l_t) = \theta \ln c_t + (1-\theta)\ln(1-l_t), \qquad 0 < \theta < 1, \tag{5.6}$$

where c_t and l_t represent period t consumption of an importable good and labor. Two goods are produced in this economy: the first is not consumed domestically, while the second (the importable good) is produced domestically and can be obtained from abroad.

We assume that the output of the exportable good (y_1) is constant and can be sold abroad at a price (expressed in terms of the importable good) of T_t, which in our economy represents terms of trade. The production technology for the importable good is described by

$$y_{2,t} = e^{zt} k_t^{\alpha} l_t^{1-\alpha}, \tag{5.7}$$

in which α is the compensation for capital as a share of output of sector 2. As before, production in this sector is also affected by a stationary productivity shock (z_t) that follows an AR(1) process.

The resource constraint of the economy is given by

$$c_t + i_t + g_t = T_t y_1 + y_{2,t}, \tag{5.8}$$

where investment (i) and government expenditures (g) are expressed in units of consumption of importable goods.

The capital accumulation equation is

$$k_{t+1} = (1-\delta)k_t + i_t q_t, \tag{5.9}$$

where, following Greenwood, Hercowitz, and Krusell (2000), q denotes the current state of technology for producing investment goods and represents investment-specific technological change. Given that i is expressed in consumption units, q determines the amount of investment in efficiency units that can be purchased for one unit of consumption. Thus a higher realization of q directly affects the stock of new capital that will be active in production in the next period. We assume that ln q follows an AR(1) process.

As discussed in Greenwood, Hercowitz, and Krusell (2000) the relative price for an efficiency unit of newly produced capital, using consumption of the importable good as numeraire, is the inverse of q. This $1/q$ is our theoretical counterpart to p (analyzed earlier).

Finally, the government of this economy levies taxes on labor and capital income at the rates τ_l and τ_k. Part of the revenue raised by the government in each period is rebated back to agents in the form of lump-sum transfer payments (F), and part of it is "lost" in government expenditures that do not provide services to the representative agent. The government's budget constraint is then

$$F_t + g_t = \tau_k r_t k_t + \tau_l w_t l_t, \tag{5.10}$$

where r and w represent the market returns for the services provided by capital and labor. Finally, we also assume that ln g follows an AR(1) process.

The base configuration of the parameters is presented in Table 5.7. Note that θ is set to reproduce a steady-state participation rate of l equal to 0.35, and the depreciation rate is calibrated to match the average investment rate in steady state. The persistence and volatility of p, T, and g are made consistent with AR(1) estimates obtained with observed data of the relative price of equipment with respect to investment, terms of trade, and

Table 5.7. Parameters

	Preference		
	β = 0.98 θ = 0.43		
	Technology		
	α = 1/3 δ = 0.06		
	Shocks		
$\rho_z = 0.73$	$\sigma_z = 0.04$	$\rho_p = 0.844$	$\sigma_p = 0.1$
$\rho_T = 0.892$	$\sigma_T = 0.14$	$\rho_g = 0.895$	$\sigma_g = 0.024$

government expenditures (in this case we include a time trend that is absent in the model). Finally, the persistence and volatility of the technology shocks are estimated by simulation in order to match as closely as possible the results of Table 5.6.

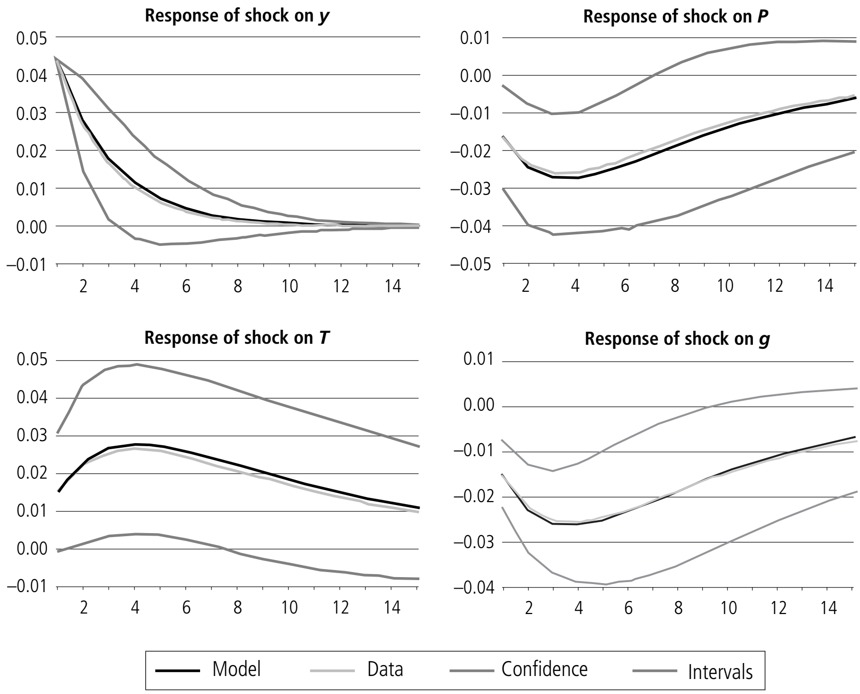
Once the values of the parameters are set, we solve the model, simulate artificial realizations from it, and compare the impulse-response functions of several shocks. According to our specification, the policy functions of the control variables cannot be obtained analytically and we have to resort to numerical methods. We use a second-order approximation to the policy function, using perturbation methods. This method has the advantage of explicitly incorporating in the decision rule the volatility of shocks and has been proven superior to traditional linear-quadratic approximations (Schmitt-Grohé and Uribe, 2001).

Figure 5.13 presents the results of comparing the impulse-response functions of shocks on the innovations of the equation that describes y in (5.5), and innovations on p, T, and g from their univariate representations. Along with the impulse-response functions and the 95 percent confidence intervals obtained from the data, the figure shows the impulse-response function obtained from a long simulation of the model. Our results evidence an almost perfect match between the impulse-response functions of the model and the data.

Analyzing the results of the impulse-response functions, we observe that a positive shock of 10 percent on the relative price of equipment with respect to consumption has a negative (but transitory) effect on GDP of almost 3 percent after three years. On the other hand, a positive shock of 14 percent on terms of trade has a positive effect on GDP that on average reaches its peak of almost 3 percent after three years. Finally, a transitory increase of 2.4 percent on the share of government expenditures over GDP has an exactly offsetting effect on GDP (a decline of 2.4 percent) after three years.

Thus our theoretical model not only is able to capture the first moments of key variables of the Chilean economy but matches almost perfectly the impulse-response functions of the dynamic characterization of GDP, showing that a model which incorporates the relative price of equipment with respect to consumption goods, terms of trade, and dis-

Figure 5.13. Impulse-Response Functions: Model and Reality



tortions (measured as the share of government expenditures in GDP) predicts the same qualitative and quantitative responses of GDP to transitory shocks.

Summary Remarks

The objective of this study was to better understand the factors behind the growth dynamics in Chile. This case study is of interest because Chile has experienced deeper recessions than most Latin American countries when faced with an external shock (e.g., the Great Depression, an oil shock, and external debt), but it has also experienced an impressive and stable growth during the past 16 years.

The main conclusions of this study can be summarized as follows:

- Looking at the evolution of GDP over the last four decades, we distinguish three periods of continuous growth: 1960–71, 1975–81, and 1985–98. The first period corresponds to a moderately inward-oriented economy; the second is the period of the major trade liberalization and market reforms; and the third is the period in which many of the reforms from the previous decade were consolidated. Two other characteristics are worth highlighting: the periods of growth had different lengths and the growth rates were different. While during the 1960s the economy grew at less than 5 percent, in the other two periods the growth rate was above 7 percent.
- But why is the recent growth period so different from the 1960s? We think this question can be answered by analyzing the behavior of TFP growth. As no reliable measures of the quality of capital stock are available, we used series for human capital along with different capital shares to estimate TFP.[10] Our results suggest that in the 1960s physical capital and human capital accumulation were the most important factors stimulating growth, while in the other two periods TFP played a major role (especially in 1975–81). Both capital accumulation and TFP growth account for the expansion of 1985–98.
- Following the literature of growth and distortions, we analyzed whether distortions have anything to do with the evolution of TFP levels after controlling for good luck (positive external shocks measured by terms of trade), exogenous technological progress, and a proxy for the quality of capital. The relative price of equipment with respect to consumption was used as a proxy for the latter variable (Greenwood and Jovanovic, 2000). We found that exogenous technological shocks, terms of trade, the relative price of equipment to consumption, and distortions account for a good deal of the evolution of TFP. It is important to note that terms of

[10] We extensively used two values: 0.507 (from pure growth accounting) and 1/3 (from the literature on growth).

trade and distortions are the variables with the largest impact on the level of TFP.

- What policy implications can be drawn from the Chilean experience that can help other countries and Chile itself? Good policies matter. The most robust measure of distortions that we found in this study is captured by the share of fiscal expenditures on GDP. We find not only that this variable offsets the positive effects of improvements in the quality of capital goods, but that it also has detrimental effects on the level and volatility of the Solow residuals. External shocks are of course important, but among the variables that can be controlled by authority, distortionary policy helps explain several episodes of mediocre Chilean growth.
- The previous findings provide guidelines for the features that a theoretical model should have if it is to account for the dynamics of our TFP estimates and the dynamics of GDP itself. Building on these observations, we calibrate, solve, and simulate a small open economy model that incorporates terms-of-trade shocks and includes the relative price of investment to consumption goods and distortionary taxes that help finance government expenditure. This model is able to replicate (almost exactly) the impulse-response functions of several shocks on the trajectory of GDP. We find that a 1 percent transitory increase in the share of government expenditures on GDP has a detrimental effect on GDP of the same order of magnitude (a decrease of 1 percent in GDP) by the third year. Transitory increases of 1 percent on terms of trade or decreases in the relative price of investment goods have positive and temporary effects on GDP, which, however, are not as important as the quantitative effects of increased distortions.

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CHAPTER 6

Economic Growth in Paraguay

Carlos G. Fernández Valdovinos and Alexander Monge Naranjo[1]

Isolated by nature, inhabited by a small and unskilled population, lacking mineral resources, punished by devastating wars, and surrounded by highly unstable neighbors, it would be surprising if Paraguay's small economy were not among the least developed in South America. Indeed, according to the index of human capital development, the country lags significantly behind most of its neighbors. As of 2000, its GDP per capita was only 50 percent of the Latin American average and only 34 percent of that of its Mercosur partners.

Poverty statistics paint an even bleaker picture. According to the 1999 Household Survey,[2] the urban poverty rate was 26.7 percent, with some 810,000 individuals barely able to buy their daily food. Moreover about 6.1 percent of urban residents, or some 184,000 people, were mired in "extreme poverty" and unable to cover basic food expenditures. The situation is even worse in the countryside, where 42 percent of families fell below the poverty line and 26.5 percent of these were below the extreme poverty line. Even by Latin American standards, development conditions in Paraguay are dire.

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[2] The survey was undertaken by the Dirección General de Estadísticas, Encuestas y Censos (DGEEC).

Given its long history of unsustainable macroeconomic imbalances, policy reversals, bad policies, and political repression and turmoil, the dismal economic performance is deeply ingrained. The average annual growth rate between 1950 and 2000 was only 1.7 percent. If we exclude the 1970s, when much of the Itaipú project infrastructure was constructed, the average drops to only 0.5 percent annually.[3] During the "lost decade" of the 1980s, Paraguay had a yearly GDP per capita growth rate of –1.7 percent. During the next decade, unlike the average Latin American country, Paraguay was essentially stagnant. Current per capita GDP levels equal those in 1976.

Undoubtedly these meager growth rates lie at the center of all other major problems in the country. Getting out of the hole and catching up will not be easy. For example, between 1990 and 1995, per capita Chilean GDP grew an average 5.3 percent per year while the rate for Paraguay was only 0.5 percent. Expressed in 1990 U.S. dollars, average GDP per capita in Latin America was $3,429 in 1995 and only $2,178 in Paraguay. Thus starting from that 1995 level, it would take a little more than 11 years for Paraguay to reach the Latin American average GDP if it could grow at the Chilean rates and everyone else stood still. At its present pace, however, it would take Paraguay 192 years to catch up. The point is obvious: growth rates have cumulative effects, and even small differences compounded over a generation or more make a huge difference in standards of living. Growth policies must be the first priority of macroeconomists and other policymakers in the region.

This chapter will examine the Paraguayan growth experience since the early 1960s, looking at different periods to try to identify the main factors behind particular levels of performance. Studying the determinants of growth is particularly important for a country like Paraguay that just recently recovered the most basic political rights and is still trying to consolidate its gain by building effective democratic institutions. Thus far the positive political trend has not been accompanied by economic growth and reductions in poverty.

[3] During the 1970s, the average per capita GDP grew at a record rate of 6.2 percent annually. It peaked at 8.6 percent in 1978.

Table 6.1. GDP Per Capita and Average GDP Per Capita Growth Rates for Paraguay and Six Country Clusters

	1960 ($)	1995 ($)	1960–70 (%)	1970–80 (%)	1980–90 (%)	1990–95 (%)	1960–95 (%)
Paraguay	1,177	2,178	1.7	6.2	–1.7	0.5	1.8
Mercosur[a]	2,571	4,132	2.3	3.0	–1.2	2.5	1.5
Latin America (21)	2,319	3,429	2.3	2.3	–1.5	1.4	1.1
Sub-Saharan Africa (17)	784	1,061	2.1	1.1	–0.8	–1.9	0.5
East Asia	1,275	8,119	4.7	6.0	4.6	4.1	5.0
OECD (22)	5,592	13,364	4.3	2.5	2.1	1.1	2.7
World (81)	2,667	6,141	3.2	2.6	0.6	1.1	2.0

Source: De Gregorio and Lee (this volume).
Note: Parentheses indicate the number of countries in the grouping; GDP per capita is expressed in 1990 U.S. dollars.
[a] Includes Bolivia and Chile.

During different periods, Paraguay's growth rates have varied sharply. Table 6.1 compares the growth performance in 1960–95 relative to Mercosur countries, Latin American countries, and the world. The average growth performance of Paraguay has not been impressive, falling far below the mean of East Asian and OECD countries. Although higher than the Latin American and Mercosur averages, this performance is deceptive, since it includes a brief bubble that was not sustained. The 1960s were a middling decade, with Paraguay growing in tandem with the region. During the 1970s, construction of the huge Itaipú hydroelectric project allowed Paraguay to match the high growth rates in East Asia, clearly outperforming the rest of Latin America. By the 1980s this stimulus had vanished and, as in the rest of the region, external debt problems, stagnation, and macroeconomic instability were reflected in negative average per capita growth rates. But in the 1990s, Paraguay fell behind its peers. While Latin America experienced a strong recovery, Paraguay turned in probably the worst relative growth performance in its recent history, with an average growth rate one-third of the Latin American average and one-fifth of that of its Mercosur partners.[4]

[4] Following a banking crisis and a strong reduction in triangular trade, economic performance was even worse in the second part of the decade. Between 1995 and 1999, the economy contracted for four consecutive years, with an overall fall in real per capita GDP of 6.5 percent, one of the worst macroeconomic performances in Latin America.

The most striking conclusion from the growth accounting exercises is that total factor productivity (TFP) has been falling over time. This result is robust to a variety of methods for measuring capital and decomposing input contribution versus productivity. We also find that physical capital had a strong pull for growth in most periods but was stronger during the 1970s and much more modest during the 1990s. We believe this reflects construction of the Itaipú dam in the 1970s and political uncertainties after Stroessner's 1989 ouster from power, respectively.

For the entire sample period, capital accumulation clearly has outpaced output, so capital availability does not seem to be the major deterrent to growth. The main problems appear in the accumulation of human capital and the overall productivity factors. If Paraguay is to grow faster, one can presume that policies should focus more aggressively on these problems. Any improvement in these areas would also foster the accumulation of complementary factors, such as physical capital.

Our analysis of Paraguayan growth follows in six stages. We begin with an overview of the most important historical events during the past half century. Then we examine the statistics on human capital and poverty, which prove to be very disappointing, even compared with those of other countries in the region. Third, we examine the importance of factor accumulation and productivity in leading output growth. Fourth, we argue that changes in fiscal variables, inflation, and some other economic variables move in tandem with growth and hence are likely to influence it. Fifth, we look at the movement of Paraguay in tandem with its main trading partners and argue that the importance of Brazil has increased dramatically in recent years. Finally, we include some summary remarks. Appendix 6.A discusses the major factors affecting incentives to accumulate capital.

A Historical Overview

Paraguay's economy has always been concentrated in agriculture. The country's small size and openness have made it very sensitive to events that affected the international market for agricultural products, causing sharp and long-lasting fluctuations that have triggered other macro instabilities, such as fiscal and exchange crises and high rates of inflation. This section will briefly review the main characteristics experienced in different economic periods since 1940.

The 1940s and 1950s were periods of important institutional changes and severe fluctuations. World War II led to sharply increased demand for Paraguayan agriculture products, sparking relatively high growth rates for the entire economy.[5] Between 1938 and 1946, average GDP grew 2.5 percent annually and exports grew 8.2 percent annually. But tight world supply and the higher demand for domestic output were also reflected in rising domestic prices. Between 1939 and 1944 the cost of living increased 300 percent for higher income groups and 50 percent for the poor. As in most countries in Latin America, this was also when Paraguay established a national currency and founded its central bank. The guarani became the country's monetary unit in November 1943, with an initial exchange rate of G 3.07 per U.S. dollar.

What appeared to be the beginning of a new and better era for the country came to a sudden halt. Cessation of world hostilities in 1945–46 was followed by a long-lasting and drastic drop in overseas demand for agricultural products. And at home, a cruel civil war erupted in 1946. Output the next year dropped by 13 percent. Problems caused by low export demand and disrupted production from social unrest persisted through the early 1950s and were exacerbated by imprudent financial policies. In an attempt to encourage production, credit policies became expansive, fueling inflation and draining foreign reserves. Inflation accelerated, reaching 160 percent in 1952. More distortions gradually appeared as a system of multiple exchange rates and exchange rate controls took shape. With the aid of an IMF mission, the government was later able to bring inflation under control and to stabilize the currency at an exchange rate pegged to the U.S. dollar (at a rate of 126 to 1).[6] Growth recovered in the latter half of the decade, with commerce and construction leading the way.

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[5] During this period, tobacco exports tripled, while vegetable oil exports increased more than sixfold, wood exports increased fivefold, meat exports doubled, and cotton exports increased 50 percent.

[6] Between 1952 and 1955 the inflation rate averaged 53 percent per year. After implementation of the stabilization plan, price increases fell to 12.2 percent per year between 1956 and 1960.

Table 6.2. Sectoral Composition of GDP
(in percent)

Sectors	1951–60	1961–70	1971–80	1981–90	1991–2000
Agriculture	38.1	34.5	29.3	26.2	26.8
Mining	0.1	0.1	0.2	0.4	0.5
Manufactures	16.7	17.1	17.7	16.5	14.7
Construction	1.5	2.2	3.5	6.2	5.4
Electricity, gas, water	n.a.	0.6	1.4	2.6	5.2
Transport and communications	n.a.	4.2	4.2	4.4	4.9
Commerce and finance	26.0	25.8	26.3	26.7	24.9
Government	4.3	4.4	4.5	4.4	5.3
Misc. services	13.3	11.1	12.9	12.6	12.3

Source: Central Bank of Paraguay.

During the 1950s foreign aid was ample, and basic physical infrastructure gradually expanded. In this respect, it is important to highlight the treaties signed with Brazil. In January 1956 Paraguay signed an agreement whereby Brazil offered to finance the studies and consign the loans necessary for construction of a hydroelectric plant in the Acaray River, close to an area where transport projects were being advanced. This treaty would become a prototype for the later treaty to construct Itaipú, which will be discussed in detail when we examine the 1970s.

As stated previously, agriculture has been the main activity in Paraguay since colonial times, and the 1940s and 1950s were no exceptions. In 1960 agriculture still accounted for almost 39 percent of GDP and employed 55 percent of the economically active population. Manufactures contributed 17.3 percent to GDP, employing 15 percent of the workforce. Over 75 percent of the value added in manufactures originated in agro-industries. During the first half of the 1960s, agriculture remained the main stimulus to economic growth. Agricultural growth, in turn, reflected migration to the eastern part of the country, including Brazilian immigration, and the expansion of transport links with Brazil and of the internal road network.

The second half of the decade was very different. Public sector works and commerce began setting the pace.[7] The government started to carry

[7] For example, during this period construction was increasing at annual rates well above GDP growth, while electricity and water growth began to exceed GDP growth.

out important programs, especially road building, hydropower development, expansion of port facilities, installation of water services for Asunción, and even the construction of a cement plant. Consequently public investment averaged 5.3 percent of GDP in 1966–70, double the rate of the previous five years. Increased investment was partly financed externally but mostly through higher public savings from rising tax revenues. Of the various investments, energy ventures to harness the country's hydroelectric potential were the most striking. Besides construction of the Acaray plant, Paraguay and Brazil signed the Acta Final in June 1966, which would become the basis for the Itaipú treaty signing of 1973.

Commerce was another strong sector, expanding by more than 6 percent per year. The main stimulus for the sector came from Argentine and Brazilian tourists attracted by the lower prices of nontradables, and the much lower taxes that Paraguay imposed on imported goods compared to the protectionist policies of their own countries.

With savings and investment hovering around 12–13 percent of GDP, the average yearly growth rate of real GDP in the 1960s was 4.2 percent, while the population was growing at 2.5 percent. After the financial chaos of 1947–54, stability was restored so that by the 1960s the cost of living was rising at an average of only 2 percent yearly. Additionally, there was total exchange rate stability, with a pegged rate of G 126 per dollar.

The Itaipú Boom

The 1970s were unusually prosperous for Paraguay. GDP growth accelerated dramatically to an average of almost 9 percent annually, doubling the performance of the previous decade.[8] The driving force came from two sectors: agriculture and construction. The former was the result of the expansion of the agricultural frontier and the latter a consequence of the surge of construction on various infrastructure projects, culminating in the building (jointly with Brazil) of the world's largest hydroelectric project at Itaipú.

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[8] In particular, the yearly real growth rate of GDP averaged over 11 percent in 1977–80.

Table 6.3. Annual Average GDP Growth by Sector
(in percent)

Sectors	1951–60	1961–70	1971–80	1981–90	1991–2000
Agriculture	1.8	3.0	6.7	4.0	1.7
Mining	n.a.	57.5	28.4	4.9	2.7
Industry		6.5	8.3	2.2	0.8
Construction	7.5	7.4	20.3	0.7	2.8
Electricity, gas, water	n.a.	11.3	17.5	7.9	10.2
Transport/communications	n.a.	37.3	9.7	3.7	4.1
Commerce and finance	3.5	4.8	9.0	2.8	–0.5
Government	3.3	7.8	4.3	5.0	5.4
GDP	2.9	4.8	8.8	3.1	2.0

Source: Central Bank of Paraguay.

Starting in the early 1970s the government accelerated efforts to expand the agricultural frontier. Heavy investment in infrastructure began, and the eastern frontier was opened to development. New lands in this fertile region were brought under cultivation through the establishment of numerous settlements.[9] These settlements were the main reason for agricultural growth in a sector that expanded on average 6.9 percent yearly during the decade. Due to rising world demand and favorable international prices, the frontier lands were mainly used for export crops, primarily cotton and soybeans, which became Paraguay's dominant exports. Cotton mushroomed from 1.1 percent of total exports in 1960 to 44 percent in 1985; while soybeans, which did not appear on export lists at all in 1960, attained a share of over 16 percent in 1981.[10] It should be noted that quebracho extracts and livestock, Paraguay's traditional exports, declined dramatically during the same period.

The highway to Brazil and the development of frontier lands substantially reduced Paraguay's traditional dependence on Argentina as its trade route. This was reflected by the dramatic increase in trade with Brazil to the detriment of other countries, especially the United States. For ex-

[9] By the end of 1976, almost 90,000 land titles had been issued, covering about 4 million hectares. Paraguayan colonists were joined by large numbers of Brazilian and Japanese farmers who came in response to several economic stimuli: low land prices, low taxes, and high world prices for farm products.

[10] Soybean exports as a percentage of total exports grew further during the 1980s and 1990s.

Table 6.4. Employment by Production Sector
(in percent)

Sectors	1950	1962	1972	1982	1992	1999
Agriculture	55.4	54.7	47.9	42.9	35.6	30.4
Industry	16.1	15.1	14.0	12.0	12.5	12.3
Construction	3.0	3.3	3.9	6.7	7.2	5.2
Transport/communications	2.3	2.5	2.8	2.9	3.3	4.3
Commerce and finance	7.1	7.1	8.0	9.3	13.9	24.8
Services	16.0	17.3	23.4	26.2	27.5	23.0

Sources: Population censuses and household surveys (various years).

ample, in 1960 only 0.2 percent of Paraguay's exports went to Brazil and 0.8 percent of imports came from there. By 1981 the respective shares were 18.3 percent and 25.9 percent.

The expanding agricultural frontier also affected regional demographics. While only 18.3 percent of the population lived in the eastern frontier region in 1962, 27.3 percent lived there 20 years later. Meanwhile about 40.5 percent of the population lived in the *minifundia* region in 1962 compared to 34.2 percent in 1982.[11] It is very important to note that because of this, and unlike most other LDCs, Paraguay did not experience a marked urban-rural migration. Instead it experienced a rural-rural shift away from the traditional *minifundia* regions to the newly opened lands.

The other major source of growth in the 1970s was construction of the Itaipú hydroelectric dam. The work, which was concentrated from 1973 to 1983, cost more than four times Paraguay's GDP and was financed externally trough the Itaipú Binational Entity. The debt was guaranteed by Brazil.[12] It has been estimated that between 1977 and 1980 around US$250 million (equivalent to 6 percent of Paraguay's GDP) were spent in Paraguay each year.

The capital inflow from the Itaipú project and the easy credit conditions in the international markets of the time translated into large in-

[11] The *minifundia* region comprises the four departments around Asunción: Cordillera, Guairá, Paraguarí, and Central.

[12] Most of this spending is not shown in Paraguay's national accounts since for this purpose Paraguay does not consider binational enterprises to be located within the national territory.

creases of liquidity and a tremendous credit expansion, while simultaneously exerting downward pressures on the real exchange rate. Internally, investment construction benefited most from the easier credit policies, growing at an average annual rate of 23 percent between 1973 and 1981. The dramatic increase from representing less than 10 percent of GDP in the 1960s to over 20 percent at the end of the 1970s stemmed from a large expansion in private investment.[13] At the same time, public investment remained at about 5 percent of GDP.

However, linkages to other sectors of the economy were weak, except for the service sector, especially commercial and financial activities. For example, in 1972 there were only six banks in Asunción. By 1981 there were 20. Commerce and finance grew at annual rates above 10 percent in 1976–80, and this sector accounted for 26 percent of GDP by 1981.

Public finances remained strong during this period and huge increases occurred in foreign reserves, which grew from less than US$20 million at the beginning of the 1970s to US$800 million in 1981. While Itaipú construction created a substantial increase in effective demand, an increase in the supply of domestic consumer goods was not immediately forthcoming, and the excess demand was only partially met by increased imports. Additionally the country, as well as the world, experienced steep hikes in oil prices. All these occurrences, combined with the increased market liquidity, resulted in strong inflationary pressures: By the late 1970s Paraguay again experienced double-digit inflation, reaching 28.2 percent in 1979.[14]

The Lost Decade

The 1980s in Paraguay, as in most of Latin America, were years of macroeconomic instability and stagnation. Much of the investment from the transitory resources flowing into the country during Itaipú´s construction was not invested prudently and, thus, did not provide a buffer for the coming

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[13] Many private sector investments later proved to be overestimated; construction investment certainly was greatly exaggerated.

[14] These inflation rates were low by Latin American standards, mainly due to the extreme openness of the economy and the overvaluation of the guarani.

letdown. After the economic boom ended in 1981, the country suffered a two-year recession. Real GDP declined by 1 percent in 1982 and by 2 percent in 1983, while unemployment soared from 3.5 percent in 1981, to 7 percent in 1982, and to 12 percent in 1983. The economy's absolute contraction stopped in 1984, but growth remained at less than 2.5 percent per year for the next three years, well below the 3 percent population increase per annum. In 1987 and 1988 recovery took place, with growth even exceeding 6 percent thanks to the agricultural sector. However, this was not enough to offset the poor performance of earlier years. By 1990, GDP per capita was 1.7 percent lower than in 1980.

Incidentally, the sectors that suffered most post-Itaipú were those that had grown most rapidly in the 1970s boom. For example, although commerce and finance was 17 percent higher in 1989 than in 1981, the sector's average annual growth rate was below that for GDP. The construction sector also was affected severely, contracting more than 6 percent in 1982 and sustaining negative growth rates in each subsequent year until 1986. Consequently construction activity in 1989 was still more than 7 percent below that of 1981. There were hopes that Yacyretá (a second hydroelectric project planned with Argentina) could counter this trend, but several problems resulted in a number of project postponements. Other sectors did not perform well either, with manufacturing output moving at about the same pace as global GDP. Basic services—electricity, water and sewerage, and transport—expanded faster than the economy, but growth also declined substantially compared to earlier years. Even though it averaged 8.5 percent growth in 1987–89, the agricultural sector was still expanding at half its rate of the previous decade.[15]

A second factor contributing to the country's stagnation was the world recession, which hit Argentina and Brazil, Paraguay's largest trading partners, particularly hard. Both countries were caught up in a period of structural adjustment that forced them to slash imports sharply and devalue their currencies. Accordingly Paraguayan exports also declined. World-

[15] However, a significant restructuring of output also occurred, shifting toward the domestic market with an impressive expansion in corn and wheat production.

Table 6.5. Composition of Registered Export Commodities
(in percent)

Products	1960	1970	1980	1990	2000
Wood products	18.7	19.7	21.4	3.9	8.6
Livestock and meat	26.5	23.8	0.3	13.9	8.1
Tobacco	5.9	9.0	3.3	0.6	0.4
Cotton	1.1	6.3	34.1	34.7	10.6
Soybeans	0.0	0.0	13.6	27.9	32.9
Vegetable oil	5.7	10.9	5.5	1.4	4.8
Quebracho extract	10.9	3.0	1.4	0.6	0.0
Others	31.2	27.3	20.4	17.0	34.6

Source: Central Bank of Paraguay.

wide recession also caused a fall in the international prices of Paraguay's main exports. For example, soybean prices decreased 2.6 percent in 1981 and 5.4 percent in 1982, while cotton prices fell 11.4 percent in 1981 and 16.7 percent in 1982 (Baer and Breuer, 1986).[16]

The increasing external imbalance and the substantial reduction in aggregated demand presented a very grim economic scenario. The government responded with a macroeconomic policy using public investment and spending to combat the post-Itaipú recession. The government also began to speed up disbursement of previously contracted foreign loans and arranged new ones. Most of the increase in external debt during this time came from public sector borrowing to finance infrastructure as well as some heavy industries like steel and cement.

However, these actions had outcomes substantially different from expectations. Investments turned out to be unprofitable and oversized for the domestic market. Sectors had been targeted in which regional markets already showed substantial excess capacity. Meanwhile, foreign debt increased dramatically, rising from 15 percent of GDP in 1981 to 62 percent in 1987. In the mid-1980s, the government stopped servicing much of its international debt, causing the country to lose access to international markets and several creditors to suspend the disbursement of previously contracted loans.

[16] Baer and Breuer (1986).

In addition to the external borrowing, internal credit expanded rapidly during this decade. Domestic credit to the public sector (including the central bank's deficit) increased sharply, contributing to the rise in prices.[17] Inflation, which had fallen from 14 percent in 1981 to 6.8 percent in 1982, doubled in 1983 and kept rising in subsequent years. The consequences of higher inflation were then amplified by the multiple exchange rate system instituted in 1982.[18] Exporters were forced to surrender part of their foreign exchange earnings to the central bank at below-market prices; the central bank then sold foreign exchange to favored buyers at a still lower price. The system generated a large central bank deficit that had to be financed by inflationary monetary emission, distorted incentives against exports, and created opportunities for private parties and public officials to engage in corruption and glean easy profits, especially as domestic price levels increased. The principal legal beneficiary of the multiple exchange rate system was the nonfinancial public sector. Although official figures suggest the sector remained roughly constant throughout the 1980s, it received explicit and implicit subsidies from the central bank and exporters that reached an equivalent of about 6 percent of GDP annually in 1986–88.

Falling Behind in the 1990s

As mentioned earlier, economic policy in the latter half of the 1970s did not prepare the country for post-Itaipú conditions since most of the transitory additional resources being generated were spent as if the flow were permanent. On top of that, when the inevitable slowdown occurred in the 1980s, it was aggravated by poor macroeconomic policy and rent-seeking practices. In part the increased rent-seeking practices were symptomatic of the cronyism rife in Stroessner's authoritarian regime. That regime, one of the longest-lasting in recent Latin American history, was weakening rap-

[17] For example, in 1978–84 domestic credit grew at an average annual rate of 26.5 percent.

[18] The exchange rate was fixed at G 126 to the U.S. dollar in 1961 and remained there until mid-1982, when a system of multiple exchange rates was introduced. Rates then ranged from 128 to 240 guaranies to the dollar, with 160 being the dominant figure.

idly and finally toppled when social unrest burst out in February 1989. As might be expected after a dictatorship of 35 years, the country embarked on a pseudodemocratic transition period characterized by a drifting, unstable balance of power that hopefully will settle with the formation of strong democratic institutions. The political uncertainty may have negatively affected the incentives to invest in the country, but in general, many important changes have taken place and the trend has been positive.

The authorities who took charge in 1989 substantially changed macroeconomic policy management. This began almost immediately with perhaps the most important reform: unification of the multiple exchange rates. Simultaneously, all foreign exchange controls were removed and commercial banks were permitted to deal in foreign exchange. This eliminated significant distortions as well as central bank losses on foreign exchange transactions, easing one of the major sources of inflation. Moreover the guarani was allowed to float, which resulted in a 92 percent nominal and a 24 percent real depreciation.

Thereafter, significant changes were made in public finances, international economic policy, and financial sector policy.[19] Regarding public finances, the public sector deficit was initially reduced, financial management of public enterprises tightened, and public investment slowed. In December 1991 a new tax code was passed, simplifying and modernizing the tax system. In particular, the new code placed greater reliance on indirect taxation, especially on the value-added tax. Additionally, the elimination of the debt to Brazil and the buyback of much Paraguayan debt to commercial banks reduced the country's interest burden and its susceptibility to external interest rate shocks.[20] In the financial sector, interest rates were liberalized in 1990 and completely freed by 1991, when they were influenced only by the central bank via the discount rate. Meanwhile selective

[19] A main economic problem in previous periods was the large but hidden public deficit, which reached around 8 percent of GDP in 1988 (including interest arrears and the public sector foreign exchange subsidy). The official 1988 figures showed a deficit of only 3.1 percent of GDP.

[20] In 1989 Paraguay reduced its debt with Brazil by over US$400 million through a swap for Brazilian debt purchased in the secondary market. In 1992, arrears to commercial bank creditors were reduced from over US$200 million to less than US$3 million through the buyback of US$172 million of debt and the restructuring of most of what remained.

Table 6.6. Main Macroeconomic Indicators

Indicators	1960	1970	1980	1990	2000
GDP growth, % per year[a]	2.9	4.8	8.8	3.1	2.0
Inflation, % per year[a]	30.3	3.4	13.1	21.7	13.4
Exchange rate, G/US$[b]	131.0	133.0	136.0	1,230.0	3,507.0
Int. reserves, US$ million	0.9	17.3	748.7	675.0	771.9
External debt, US$ million	26.7	146.9	690.6	1,669.9	2,234.3
Registered exports, US$ million	26.9	64.1	310.2	958.7	869.4
Registered imports, US$ million	32.5	63.8	517.1	1,193.4	2,050.4
Fixed investment, % GDP	7.4	12.2	26.8	21.9	18.3
Tax revenues, % GDP	n.a.	10.3	8.1	9.2	10.3
Public sector deficit, % GDP[a]	n.a.	n.a.	1.2	3.1	–0.9

Sources: Central Bank of Paraguay and World Bank.
[a] Ten-year averages: 1951–60, 1961–70, 1971–80, 1981–90, and 1991–2000.
[b] Free market price; end of period.

credit controls were abolished almost completely and reserve requirements reduced. With regard to trade policy, a new tariff code was passed in 1992, lowering and simplifying rates to bring them in line with the de facto openness of the economy.[21] Also in 1991, Paraguay joined the common market Mercosur, cosigning the Treaty of Asunción with Argentina, Brazil, and Uruguay. Since then the country has complied with treaty obligations to reduce tariffs to Mercosur partners.

Despite all the reforms, however, economic growth was far from outstanding during the first part of the decade. GDP grew an average of 3.2 percent yearly between 1990 and 1995, barely keeping pace with population growth. GDP continued to be heavily influenced by agricultural output, which was severely affected by adverse weather in 1990 and 1991 and deteriorated further in 1992. The next year brought a rebound in the agricultural sector, pushing GDP growth above 4 percent. Most other sectors in the economy during this period grew around 3 percent annually, except for basic services. This sector was the pacesetter, with an annual growth rate above 7 percent, reflecting the rural electrification program established by the power company and investment programs to increase water coverage in Asunción.

[21] External tariff rates, which ranged from 3 percent to 86 percent prior to the reform, went to 9.6 percent for manufactures, 6.9 percent for agriculture, and 3.4 percent for mining and quarrying.

Except at the outset, inflation generally remained under control during this period. The liberalization of exchange rates in 1989, adjustments on the prices of public services, and a high rate of monetary expansion due to the accumulation of foreign reserves drove inflation above 40 percent in 1990.[22] Since then the exchange rate has been used as the nominal anchor. After initially seeking to accumulate international reserves and to protect export competitiveness, the government began to worry more about domestic inflation, shifting the priority in exchange rate management toward price stability. Consequently the exchange rate was devalued to a level below inflation, and the guarani started to appreciate in real terms. Inflation was gradually lowered from 44.1 percent in 1990 to 13.4 percent in 1995, when the policy was derailed by a banking crisis.

The overarching reforms of the financial sector were undertaken in 1989 and 1990, aimed at introducing a market-based system of monetary management. The underdeveloped and heavily regulated financial sector was suddenly deregulated in an environment characterized by implicit deposit insurance and relatively good, but weakly enforced, prudential regulations. This was compounded with a slight appreciation of the real exchange rate during the nominal anchor period, which contributed to a rapid consumption increase that resulted in excessive risk-taking by financial institutions. As a result, a full-fledged banking crisis erupted in 1995. A second round of bank failures followed in 1997.[23] Thirteen domestic banks (about a third of the banking system) and a number of other financial institutions failed post-1995. The cumulative cost of the banking crisis by 1998 reached an estimated 13 percent of GDP.

During the second half of decade, monetary conditions reflected the increasing financial needs of banks in distress. From the middle of 1995 through 1997, the central bank was forced to absorb the costs of the crisis.

[22] From March 1989 through 1991, the central bank accumulated more than US$700 million in foreign reserves, equivalent to nearly 20 percent of GDP. Most of these resources were later used to solve Paraguay's external debt problems.

[23] Many actors share blame for the crisis. Some bankers were inexperienced; a few were dishonest; some auditors were incompetent; the Superintendency was impotent; and the public conveniently turned a blind eye, assuming the government would not leave them out in the cold if a fire erupted (World Bank, 1999).

In order to mitigate the inflationary impact of credit awarded to troubled financial institutions, monetary growth was reduced. The exchange rate was defended by selling foreign reserves, as rehabilitation credits were sterilized. In December 1997, after reserves had declined by nearly 40 percent from their 1996 peak, the central bank abandoned its support of the guarani, which depreciated by some 20 percent. The weakening domestic economy kept inflation below the rate of depreciation and, in real effective terms, the guarani depreciated during this period.[24]

In the fiscal area, structural reforms and a comprehensive adjustment in 1990 led to a series of surpluses during the first half of the decade that helped reduce the country's debt burden. For several years prior to 1997, the nonfinancial public sector achieved surpluses averaging around 2 percent of GDP annually.[25] Beginning in 1997, however, the balance slipped into deficit, caused mainly by weakened tax collection, strong wage growth, and the need to undertake long-delayed maintenance investment. Public enterprises also saw their cash flow squeezed as tariffs were not adjusted in line with costs. Moreover, the social security system lost its surplus position after half of its assets were frozen in banks that had undergone government interventions and ceased to earn interest. The public sector deficit reached more than 5.5 percent of GDP in 2000, when spending surged, financed by a large injection of external debt.[26]

As mentioned earlier, economic growth was moderate in the early years of the 1990s and accelerated briefly during a mid-decade credit expansion. However, the banking crisis brought the expansion to a halt in 1996, and since then the economy has undergone sustained contraction. As

[24] Inflation initially picked up to 14.6 percent at the end of 1998 but rapidly declined to single digits the following year.

[25] The surpluses were mainly explained by the increase in revenues. For example, central government revenues increased from about 8 percent of GDP in the late 1980s to about 15 percent in 1997. Most of the increase was due to import taxes, imposed on triangular trade, and the 1992 introduction of a 10 percent value-added tax. Nevertheless, most of the additional revenue was spent on personnel, expenditures for which rose from 3 percent of GDP in 1990–92 to about 7 percent in 1997.

[26] Paraguay's public external debt has doubled over the last five years to about 32 percent of GDP. In 1999 the country obtained a loan from Taiwan of US$400 million, equivalent to 30 percent of the external debt at the time. The government spent the full amount in 1999 and 2000 in a futile attempt to reverse the economic stagnation.

a result of the problems in the financial system, private sector credit contracted sharply and real interest rates rose to around 25 percent, while depositors increasingly shifted toward U.S.-dollar-denominated assets. Additionally, the recession led to a sharp rise in nonperforming loans and increased bank reluctance to extend credit to the private sector. Increasing capital flight during recent years reflected a deep lack of confidence and compounded the shortage of credit in the financial sector. The steep decline in investment, falling terms of trade, slow growth among trading partners, and a contraction of the re-export business combined to reduce real GDP, at first per capita and then, in 1998 and 2000, absolutely.[27] As a consequence, poverty deepened—especially in rural areas—and income distribution became more unequal.

Poverty, Inequality, and Social Indicators in Paraguay

The previous section showed that, during the past 50 years, the economic performance of Paraguay has gone trough different stages. The 1960s were years of increased growth and financial and political stability compared to the previous decades, with commerce and construction being the main sources of growth. In the 1970s Paraguay had a good economic performance thanks to agricultural expansion and the construction of large hydroelectric projects. After the completion of the main works at Itaipú in 1981, the Paraguayan economy entered a deep recession that lasted well into the mid-1980s. Economic recovery started in the first half of the 1990s but a combination of factors, both domestic and external, led to a new recession over the second half of this decade. A glance at the social indicators available over this whole period shows that, in spite of some improvement over time in many of them, the bulk of the Paraguayan population continued to live at a fairly low standard.

In this section we provide a brief summary of poverty, income distribution, health and education environment in Paraguay. Data for some important economic and social indicators became available only in recent

[27] The average growth rate of real GDP was only 0.7 percent per year in 1996–2000.

years. For example, the household survey program in Paraguay started in 1983, and data have been collected once every year since. However, until 1993 the surveys covered only the metropolitan area of Asunción, and the first national survey was implemented only in 1995. All these issues have placed important constraints on the analysis of this section.

The share of the population living in poverty is still high in Paraguay, both in the metropolitan area and in the country as a whole. According to Robles (1999), the population in poverty in the metropolitan area of Asunción has been steadily decreasing between 1983 and 1997. In 1983, the share of the population in poverty was 55.4 percent (of which, 16.2 percent were in the extreme poverty category). By 1990, this share was 41.6 percent (11.9 percent in extreme poverty) and by 1997 it further decreased to 23.7 percent (4.0 percent). At the same time, Robles notes, inequality, as measured by the Gini index, has remain stable in the metropolitan area during most of the period, but increased slightly in the most recent years. The Gini index has a value of 0.473 in 1983, 0.449 in 1987, 0.445 in 1990, 0.472 in 1993, 0.503 in 1995 and 0.483 in 1997.

Complementarily, the World Bank (2001) found that, between 1995 and 1999, the share of the population in poverty rose from 30.3 percent to 33.7 percent (Table 6.8). At the same time, the share of the population in extreme poverty increased from 13.9 to 15.5 percent. These increases were largely due to the country's poor economic performance. A severe banking crisis, falling agricultural prices, and other shocks combined to produce the worst macroeconomic performance in Latin America, with four consecutive recessionary years and an overall per capita GDP contraction of 6.5 percent. During this period, the ranks of the extreme poor rose by 75,000

Table 6.7. Poverty and Inequality Indicators in the Metropolitan Area of Asunción

	1983	1987	1990	1993	1995	1997–98
Extreme poverty	16.2	16.0	11.9	11.2	6.0	4.0
Poverty	39.2	32.2	29.7	24.8	21.5	19.7
Gini index	0.473	0.449	0.445	0.472	0.503	0.483

Source: Robles (1999).

Table 6.8. Percentages of Population in Poverty and Extreme Poverty (1995–99)

	1995	1996	1997–98	1999
Poverty				
Country	30.3	n.a.	32.1	33.7
Urban	23.7	21.2	23.1	26.7
Rural	37.2	n.a.	42.5	42.0
Extreme poverty				
Country	13.9	n.a.	17.3	15.5
Urban	6.8	4.9	7.3	6.1
Rural	21.4	n.a.	28.9	26.5

Source: World Bank (2001).

and the ranks of the poor by 180,000. The impact has been severe for households in smaller cities and especially severe for those in rural areas, both of which were more affected by the economic downturn than Asunción.[28] Today, although rural areas account for less than half the country's population, they account for almost 80 percent of the extreme poor and 57 percent of the poor.

Inequality has also increased, contributing to the high poverty rates. In the 1980s the prevailing wisdom was that Paraguay had an equitable distribution of income (due to a relatively low level of inequality in metropolitan Asunción), but when national survey data became available, it became apparent that the country actually ranked among the worst in Latin America. Inequality at the national level, as measured by the Gini index, increased further in the second half of the 1990s, rising in rural areas while remaining stable in urban areas (Table 6.9). Decompositions of inequality measures according to household characteristics suggest large differences in income by education level, geographic location, and economic activity. According to the World Bank (2001), geographical location, education, and employment are found to account for at least one-fifth of national inequal-

[28] According to some studies, rural poverty may have begun rising as far back as 1980, even during relatively prosperous periods for the economy as a whole and even when urban poverty was declining. These studies suggest that while extreme poverty fell in Asunción between 1983 and 1992, it rose in the countryside during a comparable period (1980–92).

Table 6.9. Changes in the Gini Index of Income Inequality (1995–99)

	1995	1996	1997–98	1999
National	0.581	n.a.	0.592	0.597
Urban areas	0.515	0.485	0.502	0.497
Metropolitan Asunción	0.476	0.476	0.451	0.472
Rural areas	0.563	n.a.	0.609	0.664

Source: World Bank (2001).

ity. Household size matters less. While these findings are not surprising (with similar findings having been noted in many other countries), the important message is that disparities in education seem to have increasingly impacted income inequality over time.

While there has been virtually no growth in per capita GDP over the last two decades, Paraguay has shown progress in some nonmonetary indicators. For example, the United Nations Development Programme's (UNDP's) Human Development Index (HDI) for Paraguay improved from 0.663 in 1975 to 0.738 in 1999, but it remains below the level achieved by most other Latin American countries (Table 6.10). The improvement in nonmonetary indicators despite lackluster growth may be surprising, yet it could be due to higher public sector social spending and urbanization. However, Paraguay's progress on the HDI (an increase of 0.075 over 25 years), while similar to the improvements observed in Argentina and Uruguay, has been below that observed in countries more comparable to Paraguay such as Bolivia, Chile, and Colombia.

Table 6.10. Human Development Index Levels in Six Latin American Countries (1975–99)

	Paraguay	Uruguay	Chile	Bolivia	Argentina	Colombia
1975	0.663	0.755	0.700	0.512	0.784	0.657
1980	0.698	0.755	0.735	0.546	0.798	0.686
1985	0.704	0.779	0.752	0.572	0.804	0.700
1990	0.716	0.800	0.779	0.596	0.807	0.720
1995	0.733	0.813	0.809	0.628	0.829	0.746
1999	0.738	0.828	0.825	0.648	0.842	0.765

Source: World Bank (2001).

Table 6.11. Trend in Illiteracy Rate and Net Enrollment Rates

	1960	1970	1980	1985	1990	1997
Illiteracy rate[a]	25.6	20.0	22.8	n.a.	9.7	8.4
Men[a]	19.0	15.2	20.0	n.a.	8.3	6.9
Women[a]	31.5	24.8	25.5	n.a.	11.8	9.8
Enrollment primary	n.a.	n.a.	88.7	89.5	92.8	91.2
Enrollment secondary	n.a.	n.a.	n.a.	25.4	25.8	37.9

Sources: UNDP (2003) and World Bank (2001).
[a]Years 1962, 1972, 1982, 1992 and 2000.

Paraguay has also made substantial progress in educating its labor force over the last decades, but it still lags behind in enrollment in secondary education. According to the UNDP, illiteracy, in the population aged 15 years and over, decreased from a high of 34.2 percent in 1950 to 22.8 percent in 1982. It was further reduced to 9.7 percent in 1992 and to 8.4 percent in 2000–01. Also, as indicated in Table 6.12, the number of years of schooling for the population aged 15 and over has increased gradually since 1970, but it was still barely over 6 years in 2000. That is, Paraguay still lags behind for enrollment in secondary education. This suggests that there is a low transition from primary to secondary school, which is one of the issues that education reform has addressed by expanding the primary cycle to nine years instead of six.[29] The same table shows that the number of years of schooling in Paraguay is low when compared to other countries in the region. The relatively low level of the population's human capital, as measured by the number of years of schooling, could be an important factor in explaining the meager economic growth rates observed in Paraguay in recent years.

Regarding the quality of education, multilateral agencies have found that education efficiency is low. The massive recruitment of primary school teachers, with low proportions of certified ones, to face the increasing demand for education during the 1990s negatively affected the quality of the education system. In 1997, only 59.1 percent of teachers held the proper academic qualification to teach while 66.7 percent were certified to teach.

[29] Returns to education in Paraguay are similar to those found in other countries in the region. Psacharopoulos (1994) found that the coefficient on years of schooling in a Mincerian regression was 11.5 percent in Paraguay, 10.3 percent in Argentina, 14.7 percent in Brazil, 12.0 percent in Chile and 9.7 percent in Uruguay.

Table 6.12. Average Years of Schooling in the Population Aged 15 Years and Over

Country	1970	1980	1990	2000
Argentina	6.2	7.0	8.1	8.8
Brazil	3.3	3.1	4.0	4.9
Chile	5.7	6.4	7.0	7.6
Paraguay	4.2	5.1	6.1	6.2
Uruguay	5.7	6.2	7.1	7.6

Source: UNDP (2001).

Paraguay's fertility rate (and consequently, its rate of population growth) is among the highest in Latin America, even though it has been decreasing over time. The country´s fertility rate was 6.6 in the period 1960–65, 5.7 in 1970–75, 5.3 in 1980–85, 4.6 in 1990–95 and 4.2 in 1995–2000. The average fertility rates for the countries in Latin America and the Caribbean during the same periods were 6.0, 5.1, 3.9, 3.0 and 2.7.[30] The World Bank (2001) also found that fertility rates have decreased in the 1990s, but with a leveling off in recent years. The fertility rate diminished from 4.6 in 1987–90 to 4.3 in 1990–95 and has remained stable since. However, fertility rates in rural areas are still 60 percent higher than in urban areas: for the same periods, fertility rates in rural areas diminished from 6.0 to 5.6, while in the urban area the rate declined from 3.6 to 3.2. At the same time, the life expectancy of the population has been increasing. According to the UNDP (2003), in 1950 the life expectancy of a typical Paraguayan was only 62.7 years. In 1960 it was 63.8 years, in 1980 it reached 65 years, and in 1990 it was 67.1 years, while at the end of 2000 it reached 70.1 years. Both factors have put pressures on the yearly rate of economic growth necessary to raise per capita income in the country.

Finally, while there has been no increase in per capita GDP and probably no decrease in poverty over the last two decades, there has been a reduction in unmet basic needs.[31] The share of households with at least

[30] See Economic Commission for Latin America and the Caribbean (1998).

[31] Paraguay's index of unmet basic needs uses six indicators: water, sanitary facilities, primary education, subsistence capacity, crowding, and housing material.

one unmet basic need has decreased by about 30 percentage points across the board. Nationally the share dropped from 86.9 percent in 1982 to 55.3 percent in 1997–98, while shares dropped from 72.2 to 44.7 percent and from 99.5 to 67.5 percent in urban and rural areas, respectively.

Accounting for Growth

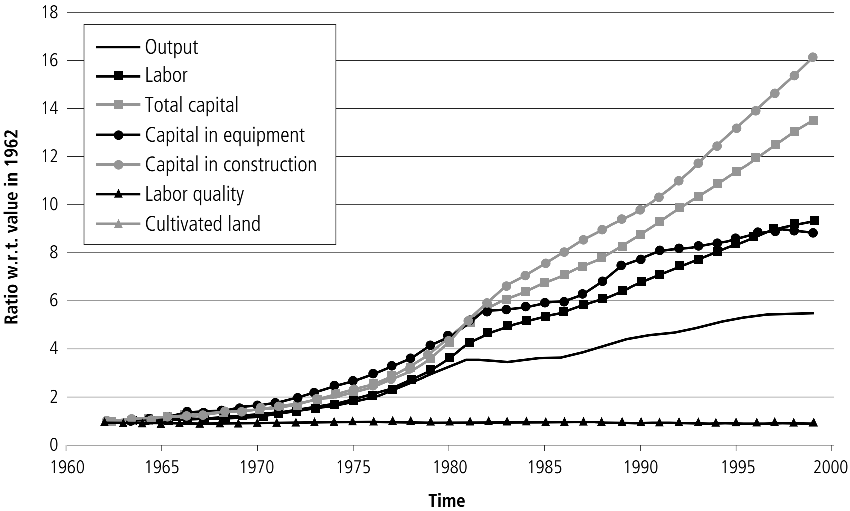
This section details a production function approach for determining the sources of growth in Paraguay during 1962–2000. The objective is to separate the impact of input accumulation from that of increased TFP on the growth of aggregate output. For reasons that soon will become apparent, a variety of methodologies are used to make the decomposition.

First, we explore the behavior of the relevant time series. Figure 6.1 displays the series for output, capital, employment, labor quality, and cultivated land. All are expressed as a ratio of their original values in 1962 except for cultivated land, which is expressed as a ratio of its 1966 value because of data limitations. While all the series clearly have been increasing consistently over time, their behavior is very different. More importantly, as discussed earlier, the growth rate of per capita output is disturbingly low.

The series for capital is estimated using the traditional perpetual inventory method, with a yearly depreciation rate of 8 percent. For almost any relevant value of the depreciation rate, the implied series for capital was found to grow much faster than aggregate output, causing us to use this rather high (but still reasonable) value to minimize the impact of a possibly artificial capital-output ratio on the growth accounting exercises. However, the qualitative conclusions are robust for using depreciation rates of 4 percent or 6 percent, changing the outcome numbers, but not dramatically. Indeed, we later will make the case that the rising capital-output ratio is simply a reflection of the poor behavior of TFP.

The employment series was constructed using the series on population and participation rates by gender from the World Bank data set. Results change little if the series in Summers and Heston (1993) is substituted instead. We also consider cultivated land as another input in production. The

Figure 6.1. Basic Aggregate Time Series for the Paraguayan Economy



numbers of hectares come from Cabello, Hosono, and Molinas (2000). The employment series corrected for labor quality was based on data about educational attainment in the workforce and variations in salaries and wages by level of schooling. Such corrections had negligible impact, which is consistent with the results of the poverty and education statistics discussed in the previous section.

Several features are evident from Figure 6.1. While all series increase consistently over time, with a notable exception discussed below, their behavior varies markedly. Importantly, as discussed earlier, the growth rate of per capita output is disturbingly low. Output spurts during the 1970s, contracts during a sharp recession in the early 1980s, rebounds timidly during the early 1990s, and subsequently declines. Capital growth also slows after the 1980s, although the capital-output ratio clearly has increased.

During the sample period, the amount of cultivated land grew significantly. It nearly doubled between 1975 and 1980, and then its growth slowed to a rate of 20 percent over the following two decades as the country approached the limits of arable land.

The figure's most striking feature is the lack of growth in labor quality. Naturally this index would not be expected to match the growth rate of other aggregate series, but the actual performance was very disappointing since Paraguay started with an index of human capital among the lowest in the region and its improvements lagged behind those in the other Latin American countries. There are theoretical and empirical reasons to believe that human capital is one of the most important factors behind growth, making the lack of human capital accumulation a prime suspect in Paraguay's meager growth rates.

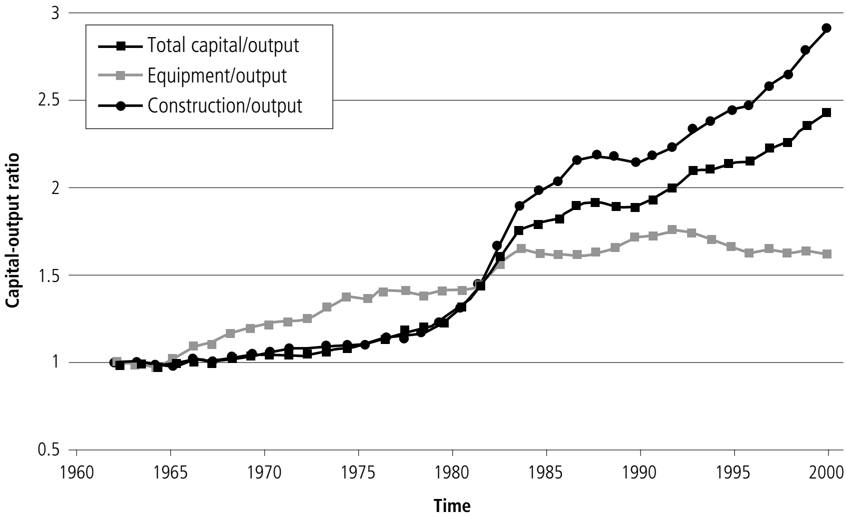
The data also point to the disparate growth in construction. Many observers in Paraguay believe there is widespread overinvestment in housing. Given this, we explore econometric specifications and growth accounting techniques that consider investment in equipment separately from construction investment. Figure 6.2 reports the behavior with respect to GDP of total capital, capital equipment, and construction capital. The series are normalized to equal one at the beginning of the period. Each outpaces output, especially construction after the mid-1970s. As the figure clearly shows, construction stock as a share of GDP rises sharply in the late 1970s and early 1980s, reflecting in part the push from the Itaipú project. But the upward trend is also present in the ratio of equipment stock to GDP, which increased by more than 50 percent during the sample period.

The only way to revert these results is to use incredibly large depreciation rates. However, the rising capital-output ratios more likely reflect declining total factor productivity. To find out, a battery of methods was employed to decompose factor accumulation and show their results.

Input Accumulation and Total Factor Productivity

Given the time series of output and different inputs, the natural questions that arise are, what quantitative contribution does each input make to output growth, and how much is attributable to an overall increase in productivity? Several different methodologies are used to perform this accounting. First, simple econometric methods are employed to estimate a production function. Then the point estimates and the regression residuals are used to

Figure 6.2. Capital Output Ratio, Using Different Measures of Capital



compute the contribution of each factor and of TFP. The second method uses the parameter values traditional in the literature (and estimated from data on other countries).

Our third decomposition is more innovative. Abandoning the Cobb-Douglas assumption, we allow for a constant elasticity of substitution (CES) production function. Using information on the share of output that goes to labor, one can estimate the substitution and distribution parameters of the production function. Then the residuals of the regression can be used to estimate a stochastic process that dictates the relative improvement in the units of capital with respect to labor. With those at hand, one can estimate a TFP-like influence and separate the contribution of factors and productivity in the behavior of growth.

The three methods are widely different and produce very different quantitative results. However, all point to declining TFP as a main cause of Paraguay's poor growth.

The first method is based on the estimation of a Cobb-Douglas production function:

$$Y(t) = A(t)K(t)^{\alpha} L(t)^{\beta}, \tag{6.1}$$

where $Y(t)$ indicates aggregate output; $A(t)$ is total factor productivity; $K(t)$ is the flow of services from capital, which is assumed to be proportional to the existent capital; and $L(t)$ represents the flow of services from labor. Taking logs,

$$y(t) = a(t) + \alpha k(t) + \beta l(t), \tag{6.2}$$

where lowercase variables indicate the natural log of the variables expressed as capital letters in (6.1). This equation can be estimated directly using ordinary least squares (OLS).[32] However, there is another way to estimate the unknown parameters in the production function, using the "intensive" form

$$\left[y(t) - l(t)\right] = a(t) + \alpha\left[k(t) - l(t)\right]. \tag{6.3}$$

This specification imposes constant returns to scale in $K(t)$ and $L(t)$.

Also, earlier in the chapter we explored an extension using cultivated land, that is, one that assumes that output is given by

$$Y(t) = A(t)K(t)^{\alpha} L(t)^{\beta} T(t)^{\chi}, \tag{6.4}$$

where $T(t)$ denotes cultivated land. However the results obtained were not interesting and point estimates on land were close to zero. This is probably due to the fact that the period in which the amount of cultivated land grew the fastest was precisely when capital was also growing very rapidly and even faster than land.

An interesting extension is the separation of capital between construction and equipment. That is, we explore an aggregate production function of the form

$$Y(t) = A(t)Kb(t)^{\alpha} Ke(t)^{\chi} L(t)^{\beta}, \tag{6.5}$$

[32] However, there are severe econometric problems with this approach (see below).

where *Kb* and *Ke* stand for the stock of construction capital and capital equipment, respectively. We also explore correcting the series for the "quality" of capital and labor. However, we have serious reservations concerning the potential quality of the correction of the physical capital series. Information on interest rates and/or capital prices, which is critical for such corrections, is very distorted and fragmented in a country like Paraguay with a long history of government intervention in the financial markets.

Additionally, we assume that the log of TFP follows a trend-stationary process of the form

$$a(t) = a_0 + a_1 t + u(t), \tag{6.6}$$

where $u(t)$ is a random disturbance. With consistent estimates of a_0 and a_1 and given the value of $u(t)$, the estimated TPF of Paraguay at time (t) is given by

$$A(t) = \exp\left[a_0 + a_1 t + u(t)\right]. \tag{6.7}$$

Depending on the stochastic properties of $u(t)$, the standard error of the estimated coefficients would need to be corrected. However, despite their popularity, econometric estimations of production functions of the previous forms have a fundamental limitation. All regression estimates of the coefficients of production functions require the orthogonality of the residuals to the regressors. Yet economic theory indicates that the amount of labor, or $L(t)$, and of capital, or $K(t)$—to the extent that it can be adjusted in the short term—must respond to the value of the residual. Thus regression estimates are inconsistent. This fact has to be borne in mind whenever interpreting the results.

Table 6.13 reports results of all the specifications, for both intensive and extensive forms. The *t*-statistics in the table are computed simply using the OLS standard errors. Beyond obviously valid concerns about the relevance of these standard errors, there are econometric problems of fundamentally higher relevance than merely obtaining robust errors. First, as cited earlier, economic theory strongly indicates that the regressors cannot be orthogonal to the residual. Periods of high TFP are also when investment is

Table 6.13. Estimation Results for Paraguay's Aggregate Production Function (1962–99)

Explanatory/Dependent	Log (Output)			Log (Output/Labor)		
Constant	0.12	0.06	0.03	0.05	0.03	0.05
	(2.47)	(4.27)	(1.60)	(1.07)	(1.00)	(1.90)
Log labor	–0.01	0.77	0.18			
	(–0.01)	(6.14)	(3.77)			
Log total capital	0.68					
	(0.96)					
Log capital equipment		0.44	0.52			
		(11.44)	(11.89)			
Log capital construction		–0.60				
		(–4.92)				
Log total capital/labor				2.29		
				(4.51)		
Log cap. equipment/labor					0.65	0.62
					(8.71)	(8.47)
Log cap. const./labor					0.28	
					(1.30)	
Time trend	–0.00	0.02	0.00	–0.04	–0.02	–0.02
	(–0.22)	(5.04)	(1.36)	(–10.34)	(–8.15)	(–19.45)
R^2	0.987	0.99	0.997	0.92	0.960	0.958

Source: Authors´ estimates.
Note: Numbers in parentheses are the *t*-statistics under the null that the coefficient is zero.

more profitable. Thus the OLS estimates are inconsistent. But perhaps even more importantly, the table shows strong anomalies in regard to the obtained estimates with respect to the literature. For example, many times the results explicitly or implicitly yield negative point estimates for one of the inputs. This happens with more strength for labor and for construction capital.

Using basic economics, it is clear that some of these results cannot be taken seriously. For instance, in the second column, the regression in extensive form yields a value for the share of labor that is in the ballpark of the literature, but it absurdly implies negative productivity of construction. We also disregard results for the first regression since it implies a negative (though negligible) productivity for labor. We also must discard results in the third column because they imply decreasing returns to scale, a problem that is not resolved by introducing land into the regression. Thus none of the extensive form regressions can be used to decompose the sources of growth. Finally, we ignore the fourth column, that is, the first regression in intensive form. It implies a huge productivity of capital and negative labor productivity, which obviously makes no sense.

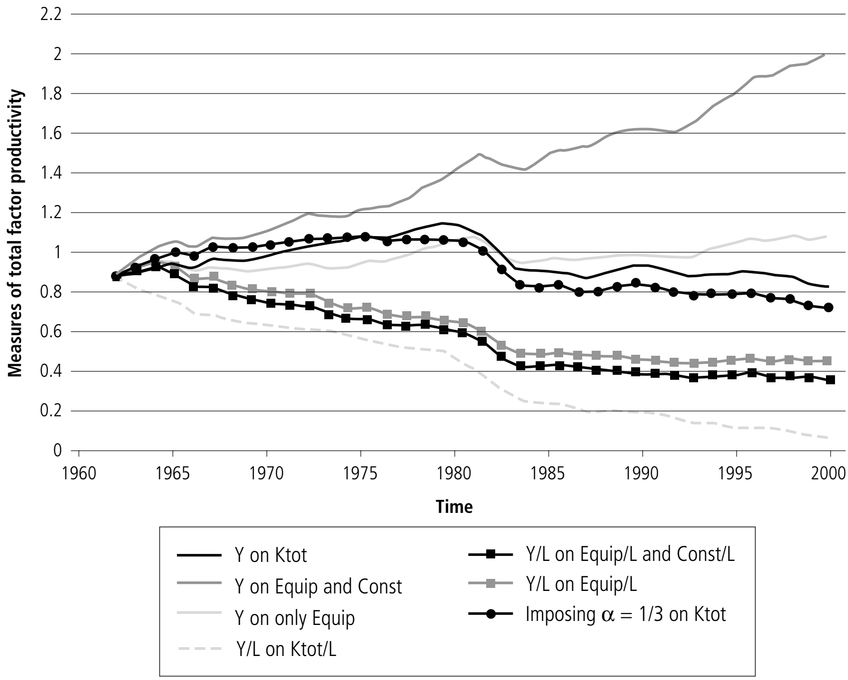
The only usable results are in columns 5 and 6. These two regressions will be used in the growth accounting exercises below. A value of 66 percent is assigned for the labor share, a percentage commonly used in the literature and one that has been obtained from data on other countries. For capital we employ the sum share of equipment and structures. (Results prove to be similar if only the stock of equipment is used for capital.) This variety of methods facilitates checking the robustness of the results.

Before exploring the third method, a remarkable finding must be noted: in most of the regressions the time trend consistently shows a negative and statistically significant coefficient. Results also show the implied behavior of TFP from the different econometric regressions to be very similar (Figure 6.3).

The low average labor share made us highly suspicious of measurement problems, especially of labor remunerations. So we recomputed the TFP and performed the growth accounting exercises by setting the value of the capital-output share to one-third, the standard in the business cycle and growth-applied general equilibrium literature. We also explored a similar exercise, incorporating land and several values for the land share, including values as high as one-third. The exercises including land provide very similar quantitative results because this variable expanded the most during the Itaipú period, which was also when capital grew fastest (Fernández Valdovinos and Monge Naranjo, n.d.).

Figure 6.3 shows the measures of TFP derived by the methods discussed above. The various methodologies yield different behavior, especially in terms of magnitude. However, there are strong similarities. Most indicate that TFP consistently grew in the 1960s and 1970s and plunged in the early 1980s. They also agree that TFP fell in the late 1990s. However, they differ on the implied behavior for the late 1980s and early 1990s. While some methods indicate that TFP starts recovering, others show it keeps falling. Nonetheless and more importantly, the vast majority of methods show a declining (or, at best, stagnant) path for total factor productivity in the economy.

Figure 6.3. Calculating Paraguay's TFP, Using Various Methodologies



Note: All series are expressed as a ratio of TFP in 1962.

Instead of refining the econometric estimation of the standard errors, we believe much higher returns can be gleaned from exploring and comparing alternative methods to extract TFP in Paraguay. One common method is to look directly at the share of labor earnings on GDP from the national accounts. Given the constant returns to scale and Cobb-Douglas functional form assumptions, one can use the average (or median) value during the sample period to estimate the labor share. Figure 6.4 vividly shows the behavior of the labor share on output for Paraguay during the sample period.

First, the share is unusually low with respect to international evidence. The average value is only 34.56 percent.

Second, the share is unstable over time. It reaches almost 40 percent in the late 1970s and falls to less than 29 percent in 1990. Interestingly,

Figure 6.4. Labor/Output Share in the Paraguayan Economy

the labor share is highly procyclical, rising during the Itaipú boom before sharply falling during the 1980s and then recovering in the early 1990s. While casting doubt on the Cobb-Douglas functional form, this behavior may also reflect measurement problems, labor market frictions, capacity utilization, relative price fluctuations, and so on. To clarify the situation, we extended the model to a CES and used information on the labor share to obtain two technological factors: TFP and a relative measure of capital efficiency.

Separating TFP and Capital-Augmenting Productivity Improvements

Imagine that instead of the traditional Cobb-Douglas, the production function takes the form of a CES; that is, aggregate output is given by

$$y(t) = B(t)\left[\theta\left(\lambda_l(t)L(t)\right)^{-\rho} + (1-\theta)\left(\lambda_K(t)K(t)\right)^{-\rho}\right]^{-1/\rho}, \qquad (6.8)$$

where $B(t)$ is total factor productivity while $\lambda_l(t)$ and $\lambda_k(t)$ are labor- and capital-augmenting technologies. The latter are quality indices that effectively act as if the total units of labor and capital had increased. We can factor out one of these two and opted to eliminate labor quality, obtaining

$$y(t) = B(t)\lambda_L(t)\left[\theta\left(L(t)\right)^{-\rho} + (1-\theta)\left(\lambda_K(t)/\lambda_L(t)K(t)\right)^{-\rho}\right]^{-1/\rho}. \quad (6.9)$$

This expression simplifies to

$$y(t) = A(t)\left[\theta\left(L(t)\right)^{-\rho} + (1-\theta)\left(\lambda(t)K(t)\right)^{-\rho}\right]^{-1/\rho}, \quad (6.10)$$

where we define the two components of productivity improvement as total factor productivity, that is,

$$A(t) = B(t)\lambda_L(t), \quad (6.11)$$

and relative improvement of capital with respect to labor, that is,

$$\lambda(t) = \lambda_K(t)/\lambda_L(t). \quad (6.12)$$

Clearly, the first term is a total factor productivity term that incorporates the common improvement of labor and capital quality.

Assuming that factor prices are competitive, then the share of output that goes to capital is

$$s_k(t) = \frac{\partial y(t)}{\partial K(t)}\frac{K(t)}{y(t)} = (1-\theta)\left[\theta\left(\lambda(t)K(t)/L(t)\right)^{\rho} + (1-\theta)\right]^{-1}. \quad (6.13)$$

After some easy manipulations, this yields

$$\frac{1-s_k(t)}{s_k(t)} = \frac{\theta}{(1-\theta)}\left[\lambda(t)K(t)/L(t)\right]^{\rho}. \quad (6.14)$$

This equation can be estimated. In particular, taking logs, one finds

$$\ln\left(\frac{1-s_k(t)}{s_k(t)}\right)=\ln\left(\frac{\theta}{(1-\theta)}\right)+\rho\ln\left(K(t)/L(t)\right)+\rho\ln\left(\lambda(t)\right). \quad (6.15)$$

We further assume that the relative capital/labor quality follows a trend-stationary process of the form

$$\lambda(t)=\exp\left(\rho\bar{\lambda}t+\varepsilon(t)\right), \quad (6.16)$$

in which $\varepsilon(t)$ is a random process. Then we obtain the equation

$$\ln\left(\frac{1-s_k(t)}{s_k(t)}\right)=\ln\left(\frac{\theta}{(1-\theta)}\right)+\rho\ln\left(K(t)/L(t)\right)+\rho\bar{\lambda}t+\varepsilon(t). \quad (6.17)$$

Note that this relationship should hold regardless of the behavior of the TFP, or $A(t)$, of the economy. Running a simple regression of the form

$$\ln\left(\frac{1-s_k(t)}{s_k(t)}\right)=\alpha+\beta\ln\left(K(t)/L(t)\right)+\delta t+\varepsilon(t), \quad (6.18)$$

one can obtain estimates of α, β, and δ. With those estimates, one can then calculate the parameters of the production function:

$$\hat{\theta}=\frac{\exp(\alpha)}{1+\exp(\alpha)},\ \hat{\rho}=\beta,\ \text{and}\ \bar{\lambda}=\delta/\beta. \quad (6.19)$$

With those estimates one can back out the implied value of

$$\lambda(t)=\exp\left[\rho\bar{\lambda}t+\varepsilon(t)\right], \quad (6.20)$$

using the regression residuals as consistent estimates of the shocks. Finally, we can compute the implied $A(t)$ as

$$A(t) = y(t) \Big/ \left[\theta \left(L(t) \right)^{-\rho} + (1-\theta)\left(\lambda(t) K(t) \right)^{-\rho} \right]^{-1/\rho}. \qquad (6.21)$$

The point estimates of the regression, using only capital equipment, are q = 1.7357e-007 and $r = -0.2491$, with an R-squared of .38. Very similar results hold if total capital is used. Thus the data suggest that capital and labor in Paraguay are more substitutable than a Cobb-Douglas production function suggests *and* that the contribution of labor is negligible.

With those estimates, we computed the implied total factor productivity and the relative efficiency of capital, which are reproduced in Figures 6.5 and 6.6.

Note that the implied behavior of TFP is in line with that shown by the previous methods, following a steady decline after the 1970s. Moreover, there are periods in which TFP and relative capital efficiency move in the same direction, especially from the mid-1970s to 1990. In that period, both TFP and relative capital quality decline gradually. This time span coincides with the Itaipú project and the lost decade. However, it is interesting that they behave very differently in the 1990s, with results sug-

Figure 6.5. Using Capital Equipment to Compute TFP and Capital-Augmenting Progress

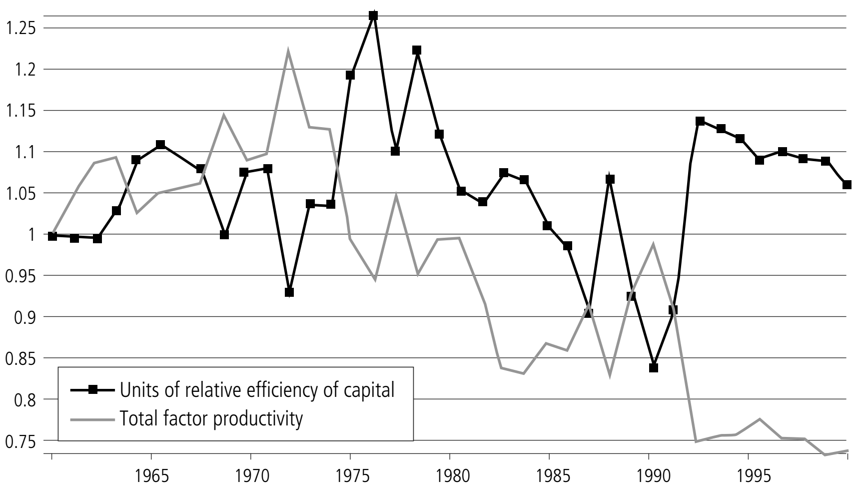
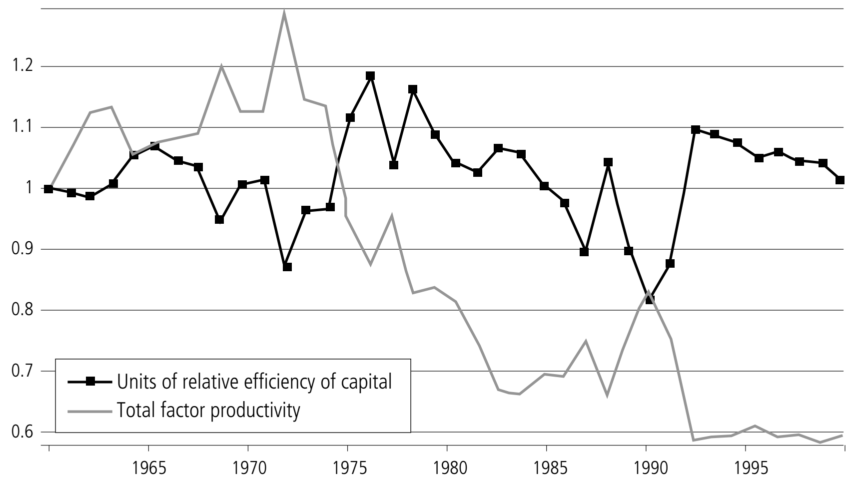


Figure 6.6. Using Total Capital to Compute TFP and Capital-Augmenting Progress



gesting that the quality of capital investment rebounded noticeably while TFP continued to decline.

Growth Accounting Results

Table 6.14 shows the results of growth in output decomposition, showing the determinants of output growth in four subperiods as well as the whole sample period. Each panel shows the percentage accumulated growth in output, measured as log differences, and the contribution to output growth from total factor productivity and from the accumulation of production inputs, using the parameters for the labor share. The first two panels show the results for the methods employing the typical value of labor share used in calibrations. The first uses capital as the sum of structures and equipment, while the second employs capital as equipment only. The third panel reports the same calculation, but using coefficients estimated from the regressions previously cited. The fourth panel also uses the regression estimates, but considering structures and equipment separately. The last panel uses the CES specification.

Table 6.14. Productivity and Factor Accumulation Contributions to Output Growth
(in percent)

Labor share = 2/3, all capital				
	Output	TFP	Capital	Labor
1962–70	36.5	7.2	13.4	15.8
1971–80	78.5	–22.8	33.9	67.4
1981–90	22.0	–25.7	17.4	30.3
1991–99	19.8	–16.0	14.3	21.5
1962–99	170.7	–64.8	86.5	149.0

Labor share = 2/3, equipment only				
	Output	TFP	Capital	Labor
1962–70	36.5	2.0	18.7	15.8
1971–80	78.5	–19.5	30.6	67.4
1981–90	22.0	–21.5	13.2	30.3
1991–99	19.8	–6.2	4.5	21.5
1962–99	170.7	–51.1	72.8	149.0

Regression, equipment only				
	Output	TFP	Capital	Labor
1962–70	36.5	–7.3	34.8	9.0
1971–80	78.5	–16.8	57.2	38.2
1981–90	22.0	–19.8	24.6	17.1
1991–99	19.8	–0.8	8.4	12.2
1962–99	170.7	–49.6	136.0	84.4

Regression, equipment, and structures separated					
	Output	TFP	Equipment	Construction	Labor
1962–70	36.5	–13.2	36.1	11.7	1.9
1971–80	78.5	–15.7	59.3	27.0	7.9
1981–90	22.0	–24.3	25.5	17.2	3.6
1991–99	19.8	–5.0	8.7	13.6	2.5
1962–99	170.7	–64.4	141.0	76.6	17.5

Regression, CES, and separation of TFP and relative capital efficiency					
	Output	TFP	Labor	Capital	Rel. capital eff.
1962–70	36.5	18.9	0.0	23.7	–6.1
1971–80	78.5	–30.0	0.0	101.1	7.4
1981–90	22.0	1.9	0.0	45.4	–25.3
1991–99	19.8	–35.0	–20.1	32.3	22.6
1962–99	170.7	–54.1	170.0	202.3	192.6

Source: Authors' estimates.

Growth accounting in this last case is not as straightforward and requires more elaboration since it is impossible to decompose linearly the contributions of the different production inputs. Accordingly the sum of the contributions between factors and TFP across subperiods need not add up. The table reports the one-factor contribution. That is, we computed how much output would have grown if only a single factor were augmented by the value at the end of the subperiod, with all other factors remaining constant from the outset. For example, in calculating labor's contribution to output growth between 1971 and 1980, we compute the implied output with the 1980 labor value but using the 1971 values for capital, capital efficiency, and total factor productivity. We then record the log difference with the actual output of 1971. As with the other cases, here we multiply those differences by 100 to express them in percentage terms.

The most striking feature in the table is that, indeed, TFP has had a negative impact on output growth in most periods. All the methods basically point in that direction. Perhaps the negative impact of TFP is weaker in the method allowing for a CES production function. Yet in this case, note that in the subperiods when TFP has a positive contribution, capital efficiency typically is significantly negative. In sum, the growth decomposition indicates that the productivity of factors, much more than their accumulation, is a major negative factor in the growth process of Paraguay.

The exercises also generally show that physical capital had a strong pull for growth in most periods, but all agree that the contribution was much higher in 1971–80, precisely when Itaipú was being built. Furthermore all the methods agree that the contribution of capital in the 1990s has been modest compared to that in other periods. We believe that the decade's political uncertainties have lessened incentives to invest in physical capital in Paraguay. However, for the entire sample period, capital accumulation clearly has outpaced output, so its accumulation does not seem to be the major deterrent to growth. The main problems appear in the accumulation of human capital and the overall productivity of factors. It seems safe to conclude that if Paraguay is to grow faster, more aggressive policies should focus on these problems. Any contribution in this respect would also have the benefit of fostering the accumulation of complementary factors, such as physical capital.

Discussion

Without any doubt, the most salient finding is the behavior of TFP. Not only does it show a weak growth overall, but more strikingly, there is strong evidence for a persistent decline during the 1980s, and more surprisingly during the 1990s. The decline in the 1980s is not really surprising in light of the results for most Latin American countries. But an open question is why TFP fell during the 1990s.

The data available at this point are not very useful in addressing this issue. Hence, we can only speculate. A possible explanation lies in the political uncertainty due to the transition from a dictatorship to an infant democracy. The presence of labor and credit market rigidities would impede the reallocation of labor and capital, and under increased uncertainty, the underutilization of capital and labor could be reflected in a decline of TFP. Another part of the explanation would rely on the lack of reforms during the 1990s. As opposed to most Latin American countries, and especially the ones in the Southern Cone, Paraguay showed very little progress in its privatizations and trade reforms. Paraguay has been less successful in attracting foreign investment than the rest of the region. These factors could be underlying the departure of the behavior of Paraguay from that of its neighbors. An additional force behind a decline in TFP could arise from the disruption of the banking system during the 1990s. The banking crisis observed during that period could have prevented the allocation of capital to the most productive uses. Finally, the implementation of Mercosur may have represented a negative TFP shock to the Paraguayan economy, as it eliminated the role of Paraguay as the middle man for trade among its neighbors.

An entirely different set of explanations can be found in the fiscal incentives to overaccumulate capital and incentives to overreport investment and/or underreport income. Such hypotheses find support in cases like Itaipú, discussed above, and the fact that structures have been accumulated at a faster pace than equipment in Paraguay. It is widely believed that equipment has a higher contribution to growth than structures. It is also widely believed that there is a huge problem of income tax evasion in Paraguay.

Finally, it would have been useful to have data on input prices, that is, wages and rental rates of capital and land. In the absence of distortions and rigidities, the behavior of wages and interest rates indicates how productive labor and capital have been in Paraguay, and with the information on their quantities, one could construct alternative series of productivity. Moreover, the behavior of relative wages (i.e., across skill groups and industrial sectors) could be used to sharpen our analysis of aggregate productivity and its composition across sectors. Furthermore, such information could be used to understand the degree of complementarity or substitutability of capital with regard to different forms of labor. This is important, as it is very likely that the degree of capital-skill complementarity has changed significantly in recent years as a result of regional integration agreements. But again, the lack of data is the main limitation.

Assessing the Macro Climate for Growth

Empirical studies analyzing the long-run determinants of growth typically relate real per capita increases to two kinds of variables: initial-levels-of-state variables such as stocks of physical and human capital, which have been our focus thus far, and environmental and policy variables—including the ratio of government consumption to GDP, the ratio of domestic investment to GDP, movements in the terms of trade, inflation, measures of political instability and the rule of law—to which we now turn. This second kind of empirical study usually employs cross-country data to identify which policy and institutional factors are significant to the growth rate of real GDP.[33] That is, analysis is based on a general framework of cross-country regressions, putting the experience of an individual country in a global

[33] For example, De Gregorio and Lee (this volume) examine the growth experience of Latin American countries, while Barro (1991) uses cross-country data from developing and developed countries.

context. Since these regressions apply to a panel of cross-country data spanning decades, the papers contain limited time series variation.

Although cross-country data seem to support the hypothesis that several external environmental and policy variables can affect output growth, it is important to test whether these findings hold in a particular country over time. Yet testing time series data for a single country can be tricky. Part of the problem is defining the appropriate time span suitable for detecting long-run relationships. Our analysis uses a nonstructural low-frequency point of view to examine the basic proposition that the economic growth rate and some of the factors usually considered in growth regressions are correlated. The methodology is based on Lucas (1980), which empirically illustrates two central implications of the quantity theory of money: that a given shift in the rate of change in the quantity of money induces (1) an equal change in the price inflation rate and (2) an equal change in nominal interest rates. Since the two propositions hold only in the "long run," Lucas constructs a filter to smooth the original data (i.e., to extract its long-term components) before testing the implications of the theory.

We use the approximate band-pass filter developed by Baxter and King (1995) to obtain the low-frequency components of the time series. For the empirical applications, we use the business cycle definition suggested by the procedures and findings of National Bureau of Economic Research (NBER) researchers such as Burns and Mitchell (1946), specifying cyclical components spanning eighteen months to eight years.

Specifying the business cycle as fluctuations with a specified periodic range results in a particular, two-sided moving average (a linear filter). In this case, the band-pass filter passes through time series components with fluctuations of eight or more years while removing the NBER business cycle components that occur more frequently. However, the resulting moving average is of infinite order, and an approximation to this filter is necessary for it to apply to a finite time series. Therefore, in order to analyze the hypothetical long-term relationship between economic growth and each factor considered, we first apply the following filter to the original time series data:

$$y_t^* = \sum_{j=-k}^{k} a_j y_{t+j}, \tag{6.22}$$

in which y_t^* is the value of the filtered series. The optimal approximate filter weights (a_j) are functions of the weights of the ideal low-pass filter (b_j) and an adjustment term (θ). Thus:

$$a_j = b_j + \theta.^{34} \tag{6.23}$$

A parameter to be chosen is the value of k, the number of leads and lags in the filtered series. Since this value has been set to equal six,[35] the approximate band-pass used in this analysis is the $BP_6(8)$ filter described in Baxter and King (1995). That is, the filter passes through data components with cycles longer than eight years, and six leads and lags of the data are used in constructing the filter (reflecting the annual observations lost at the beginning and end of the sample period for the filtered data).

A wide variety of external environmental and policy variables could affect growth rates by changing long-term potential income and the rate of productivity growth. Based on previous empirical research results, the following variables are considered as important determinants of long-run per capita income: (1) the inflation rate, (2) government consumption, (3) the investment rate, (4) private consumption, (5) exogenous shock (terms-of-trade growth), and (6) export growth.

Inflation rate: In recent years, the contours of an inverse connection between inflation and growth across countries have begun to emerge from econometric studies. For example, Barro (1991) reports a negative relationship between inflation and the growth rate of real GDP during 1970–85 in a cross section of 117 countries. Similarly the cross-section regression

[34] See Baxter and King (1995) for a more detailed discussion of how to calculate the ideal weights and the adjustment term in constructing the approximate band-pass filters for economic time series.

[35] There is a trade-off when choosing the value of k. Increasing k leads to a better approximation of the ideal filter but results in more lost observations. Baxter and King (1995) proposed a value of three or six to filter annual data.

estimates of Fischer (1993), based on data from the Penn World Table compiled by Summers and Heston (1993), from 1960 to 1989 indicate that an increase in inflation reduces GDP growth, other things being equal. Given supporting theoretical models such as Jones and Manuelli (1995), Wu and Zhang (1998), and Fernández Valdovinos (1999), we expect that, in the long run, an increase in the inflation rate will reduce output growth.

Government consumption: Several papers have studied the empirical regularities relating fiscal policy variables and the rate of economic growth. Some studies, like Engen and Skinner (1992), have found a consistently negative impact of the share of government spending on output growth rates, supporting the notion that smaller government sectors are associated with faster growth rates. However as Aschauer (1989) points out, it is important to distinguish between government capital accumulation and government consumption when considering the impact of government spending on output growth. While the former could spur productivity growth, the later could distort private decisions and curtail growth. Thus when considering the long run, an increase (growth) in the ratio of government consumption to GDP will have a negative relationship with output growth.

Investment ratio: In the neoclassical growth models of Solow (1956) and Swan (1956), an exogenously higher value of the ratio of real gross investment to real GDP raises the steady-state level of output per effective worker so that the growth rate tends to increase. For example, De Gregorio (1992), using a five-year data panel for 12 Latin American countries, between 1950 and 1985 finds the low investment rate to be one of the most important factors inhibiting growth. Additionally Bradford de Long and Summers (1991) found that machinery and equipment investment has a strong association with growth and that this correlation is much stronger than those between growth and any other investment component. Hence an increase in the ratio of machinery investment to GDP will result, in the long run, in a higher rate of output growth.

Private consumption: In the neoclassical growth models, a higher savings rate raises the steady-state level of output per capita, thereby increasing the growth rate for a given GDP starting value. So even though the savings rate does not affect long-run growth, economies with higher savings rates for a given level of initial income will grow faster in the transition period. Accordingly, given a level of income, greater private consumption means a lower savings rate and, therefore, a lower growth rate.

Terms-of-trade shock: Following De Gregorio and Lee (this volume), the terms-of-trade shock could be considered as an exogenous variable that affects the growth rate of an individual economy. An improvement in the terms of trade makes a country produce more and expand its export sector. Based on data from Latin American countries, the regression results from these authors show a significant positive relationship between change in the terms of trade and per capita GDP growth. Thus over the long run, an increase (growth) in the terms of trade will positively influence output growth.

Exports: Since researchers began exploring the links between trade and growth in the 1970s,[36] considerable empirical evidence has been compiled supporting the notion that less protectionist regimes grow faster. For example, Frankel and Romer (1999) use instrumental variable estimates to analyze the effect of trade on income. Their results suggest that OLS estimates understate the effects of trade and that trade has a quantitatively large, significant, and robust positive effect on income. Complementarily, a large number of studies have found that export growth and export levels are highly correlated with GDP growth (Edwards, 1994). Hence in the long run, we expect the growth rate of exports to be positively correlated with GDP growth.

The data in this section come from various issues of the International Monetary Fund's *International Financial Statistics* and *Direction of Trade Statistics* and the Central Bank of Paraguay's *Boletín de Cuentas Nacionales*. For every variable the original annual data run from 1970 to

[36] See, for example, Balasa (1978).

Table 6.15. Correlation Coefficients with GDP Growth Rate

Variables	Original data	Filtered data
Inflation rate	–0.0997	–0.8382
Gov. cons./GDP	–0.6038	–0.5573
Δ (gov. cons./GDP)	0.0169	–0.6716
Private cons./GDP	–0.5482	–0.7506
Δ (private cons./GDP)	–0.3424	–0.9157
Investment/GDP	0.6904	0.8776
Δ terms of trade	0.1803	0.5424
Δ exports	0.5389	0.8746

Source: Authors´ estimates using the Baxter and King (1995) filter.

2000, so given the value chosen for *k*, we have 19 observations for the filtered data. In Appendix 6.B, Figures 6.B.1.A to 6.B.8.B plot the long-term relationship between GDP growth rate and eight different variables. We have used the filtered data and, for comparison, for each country we have also plotted the raw (original) data for the period 1976–94, giving also a total of 19 observations for every variable.

For all considered variables, plots of the original data show no clear relationship over time with GDP growth. However, once the data are filtered to extract their long-run components, a clear relationship emerges between the two time series. Complementarily, Table 6.15 shows the correlation coefficients of the GDP per capita growth rate and the different variables. This table confirms Figures 6.B.1.A to 6.B.8.B, since the signs of the correlation coefficients are the expected ones. For example, in the long run, the rate of GDP growth is negatively correlated with the inflation rate, the government consumption to GDP ratio and the private consumption to GDP ratio. On the contrary, a higher growth rate of GDP is observed with a higher ratio of investment in machinery to GDP, with a higher rate of growth of exports and with a favorable shock in the terms of trade.

Paraguay's Comovement with Its Trading Partners

Our analysis now examines the cyclical comovements of Paraguayan output with the outputs of countries in the Mercosur area and with the United

States.[37] The main features of the aggregate fluctuations in the seven nations are considered, exploring the direction and magnitude of output comovements across countries.[38] The study also probes the association of their business cycles, decomposing the series in output into cycles of different frequencies. Due to its widespread use in empirical economics, the Hodrick-Prescott (HP) filter is employed to mechanically decompose the individual series into a trend movement and a cyclical component. Correlation analysis is then used to summarize the extent to which the cyclical components exhibit comovements across countries. Finally, developments over time in the synchronization of the series' cyclical components are examined based on the contemporaneous cross-correlation coefficients for rolling 10-year periods.

Degree of Economic Integration

Before analyzing the correlation of business cycles across countries, we first present some data on the degree of integration between the different economies and Paraguay. We consider two widely used indicators: the share in trade and the share in foreign direct investment. Paraguay´s major regional trading partners are Mercosur, the European Union and the East Asian countries. For example, in 2001 the share of Paraguay´s trade with Mercosur (including Chile and Bolivia) amounted to 59.2 percent of total trade, and the corresponding figures for trade with the European Union and East Asian countries were 9.8 percent and 16.3 percent, respectively. Table 6.16 shows the degree of integration with the different countries in the Mercosur area and with the United States. It can be seen that trade integration with the countries considered in this part of the chapter is quite high, especially with Brazil and Argentina. Brazil has an average share of 30.1 percent in total trade (36.2 percent in exports and 28.0 percent in imports), while for Ar-

[37] In this analysis Mercosur refers to Argentina, Brazil, Chile, Bolivia, Paraguay, and Uruguay.
[38] In the theory of optimum currency areas proposed by Mundell (1961), the incidence of disturbances across regions or countries is a critical determinant in the design of those areas. Fernández Valdovinos (2000) explores the feasibility of a currency area in Mercosur, analyzing the distribution of output disturbances across countries in the region.

Table 6.16. Share in Trade and Foreign Direct Investment (Average, 1995–2001)
(in percent)

	Argentina	Bolivia	Brazil	Chile	Uruguay	U.S.
Total trade	16.5	0.5	30.1	2.4	3.9	9.0
Exports	7.9	1.3	36.2	3.9	6.6	4.7
Imports	18.0	0.1	28.0	1.8	2.7	10.5
Foreign direct investment	16.4	n.a.	10.3	1.2	5.9	34.2

Source: Authors' estimates.

gentina this share reaches 16.5 percent (7.9 percent in exports and 18 percent in imports). The importance of the other countries in total trade is not very significant: Bolivia 0.5 percent, Chile 2.4 percent, Uruguay 3.9 percent and the United States 9 percent. Regarding the stock of foreign direct investment in Paraguay, Argentina and Brazil account again for a large percentage of the total: 16.4 percent and 10.3 percent, respectively. However, the share with the United States is the largest, 34.2 percent. The contribution of the remaining countries is negligible. Hence, according to the indicators presented, Paraguay´s integration with the countries considered in this section ranges from small to considerably large.

Growth Correlations across Countries

A rough estimate of the degree of symmetry between Paraguay and the other economies in the Mercosur area and the United States can be obtained by analyzing unprocessed data from the countries. Annual data on real GDPs in the 1970–2000 period were obtained from the International Monetary Fund (IMF) and the Economic Commission for Latin America and the Caribbean (ECLAC). For each country, the GDP growth rate is calculated as the first difference of the logarithm of real GDP.

We first consider data on the growth rate of real GDP (Table 6.17). For the full period, the data show that the degree of output growth volatility has been very different, not only across countries, but also over time. For the whole 1970–2000 period, the United States by far has the lowest standard deviation (a value of only 0.022). In the Mercosur area, Bolivia and Paraguay have the lowest volatilities (with 0.031 and 0.039, respectively). The other countries are all above 0.04. Moreover, the data indicate that output fluctuations in Mercosur countries generally were larger (across all countries) during the 1980s than during any other decade. The findings also show that for most countries, and certainly for the average, GDP growth rate volatility reached its lowest value during the 1990s.[39] For Paraguay, the growth rates of real GDP have been relatively stable in all periods, with a coefficient of standard deviation above 0.04 only during the 1980s.

On the other hand, correlation coefficients reveal that for 1970–2000 Paraguayan output growth was more highly correlated with Brazil's than any other.[40] Correlations with Bolivia and Uruguay reach values of 0.38 and 0.31, respectively. In general the correlation coefficients are not particularly high, with values below 0.5 revealing moderate comovement of the other economies with Paraguay's. However, given the observed instability of the coefficients over time, it seems more plausible to examine those coefficients by breaking the sample into 10-year periods. In analysis by subsamples the correlation coefficients reflect Paraguay's dependence on the United States during the 1970s, when it was an important trading partner. Construction of the highway to Brazil, the development of frontier lands near the Brazilian border, erection of the world's largest hydroelectric project (Itaipú), and implementation of Mercosur substantially change the degree of comovements with various countries. For example, the dramatic increase in trade with Brazil that followed these events is echoed in a higher correlation coefficient for the 1980s and 1990s.[41] Note also the low correlation of the Paraguayan economy with that of the United States, expressing a negative value during the 1980s and 1990s. On the other hand, output growth correlations also have been relatively high with Bolivia and Chile, especially during the last two decades.

We have also calculated an alternative measure for asymmetric output disturbances by estimating the parameter ($\gamma_{i,j}$), defined as the standard

[39] For Argentina and Uruguay, the 1970s were more stable.

[40] This result is explained mainly by the close behavior of the economies during the 1990s.

[41] Frankel and Rose (1997) found, using data from 20 industrialized economies over 30 years, that closer international trade links result in more closely correlated business cycles across countries.

Table 6.17. Output Growth Correlations and Volatilities

Period	Argentina	Bolivia	Brazil	Chile	Uruguay	Paraguay	U.S.
Correlations with Paraguay							
1970–2000	–0.1036	0.3761	0.4751	0.1889	0.3122	1.0000	–0.0317
1970–79	0.0587	–0.8366	–0.3055	0.3957	0.3408	1.0000	0.2783
1980–89	–0.4568	0.7035	0.2195	0.6807	0.5049	1.0000	–0.1246
1990–2000	0.0833	0.4200	0.6539	0.4618	0.0460	1.0000	–0.5169
Standard Deviation							
1970–2000	0.0509	0.0310	0.0433	0.0616	0.0414	0.0389	0.0219
1970–79	0.0442	0.0176	0.0371	0.0707	0.0272	0.0229	0.0260
1980–89	0.0487	0.0279	0.0459	0.0705	0.0572	0.0444	0.0255
1990–2000	0.0508	0.0162	0.0215	0.0359	0.0368	0.0170	0.0156

Source: Authors´ estimates.

Table 6.18. Parameter Gamma, *j* = Paraguay

Period	Argentina	Bolivia	Brazil	Chile	Uruguay	Paraguay	U.S.
1970–2000	0.0672	0.0396	0.0423	0.0663	0.0472	0.0000	0.0453
1970–79	0.0486	0.0389	0.0492	0.0651	0.0290	0.0000	0.0295
1980–89	0.0795	0.0317	0.0564	0.0518	0.0518	0.0000	0.0539
1990–2000	0.0522	0.0179	0.0165	0.0319	0.0399	0.0000	0.0284

Source: Authors' estimates.

deviation (SD) of the difference in the growth rate of GDP between countries i and j, or

$$SD\left(\Delta y_i - \Delta y_j\right). \tag{6.24}$$

Thus for countries in which business cycles are symmetric and national outputs move together, the value of this measure will be small. Table 6.18 presents the estimated parameter ($\gamma_{i,j}$), using the full period and intervals of 10 years for both Mercosur countries and the United States.

Data for the entire 1970–2000 period reveal that Paraguay's business cycle usually does not conform to those of either the Mercosur countries or the United States. The value of the parameter ($\gamma_{i,j}$) is generally above 0.04, with a maximum value of 0.067 for Argentina.[42] However, when examining the behavior of the parameter gamma in 10-year intervals, business cycles with some countries seem to be more synchronized. As found previously, business cycle dissimilarities have been significantly lower during the 1990s than any other decade, especially with Bolivia and Brazil, for which the values of the parameter ($\gamma_{i,j}$) were only 0.018 and 0.017, respectively. These values are very close to those observed in some European Union countries by Fernández Valdovinos (2000).

Cross-Country Business Cycle Fluctuations

Employing the methodologies of current business cycle research, we now explore in greater depth the direction and magnitude of comovements between Paraguay and the other economies. For a particular economic variable, long-term developments are reflected in the trend of the variable, while cyclical movements are determined as short-term deviations from this trend. Yet since it can be difficult in practice to distinguish between trends and cycles, business cycle studies still face the basic problem of how to isolate

[42] In comparison, business cycle correlations have been higher in European Union countries. Fernández Valdovinos (2000) found an average value for $\gamma_{i,j}$ of 0.017, 0.019, and 0.020 during each of the three periods considered (1970–79, 1980–89, and 1990–98) for Belgium, Denmark, France, Germany, Italy, and the Netherlands.

which features in the data are associated with long-term growth and which are keyed to business cycles.

To decompose each of the time series in output into a trend component and a cyclical component, we employ the previously mentioned Hodrick-Prescott filter. The filter is applied to the logarithm of the series; and the smoothing parameter (λ) is set to equal 100, a number commonly used for annual data.

Table 6.19 presents the results. Calculations of the volatility of the output's cyclical component show greater volatility in Mercosur countries than in the United States. When analyzing the full period, the lowest standard deviations are for Bolivia, Brazil, and the United States (0.035, 0.036, and 0.021, respectively). At the same time, the coefficient is slightly larger for Paraguay: 0.047. Even when considering 10-year intervals, the conclusions are nearly identical. In addition, volatility usually has been much higher in countries during the 1980s than in any other period, except for Argentina. When Argentina is excluded, the 1990s displayed the most stability.

As for the pattern of correlation among the series, statistics reveal that Paraguay's output comovement with other Mercosur countries or the United States was usually not very high. Specifically when considering the full period, the highest values are the coefficients with Bolivia, Chile, and Uruguay (0.61, 0.72, and 0.69, respectively).[43] However, data analyzed by subperiods reveal that series comovements could be stronger for decades. For example, during the 1980s the correlation coefficient with Bolivia is 0.98; and with Chile during the 1980s and 1990s, it is 0.89 and 0.78, respectively. With the United States the coefficient has significant value only during the 1970s and is even negative during the 1980s and 1990s.[44] Note also that business cycle correlations with the Mercosur countries are, on average, much higher during the 1990s.

A question that may arise concerns changes in the output comovements over time. One possible explanation for the low correlations found

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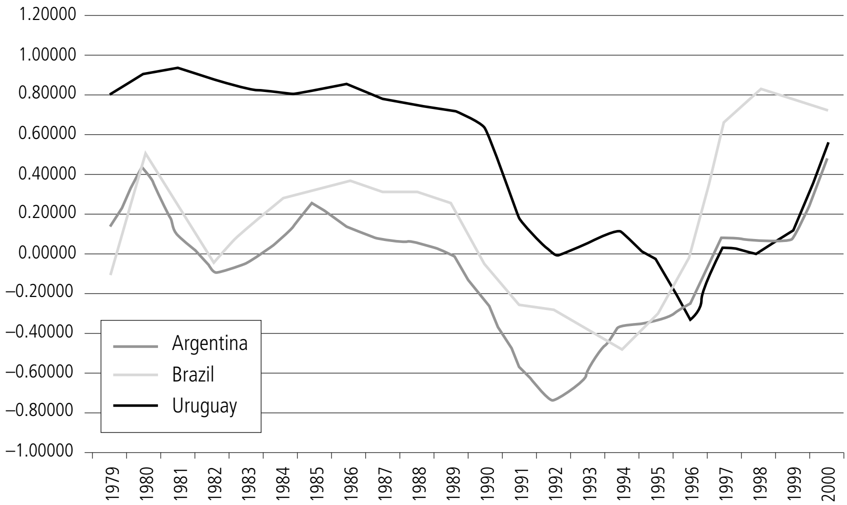
[43] Fernández Valdovinos (2000) finds that for its sample EU countries, output correlations are generally much higher. In addition, the degree of comovement is more pronounced in subgroups of countries: Belgium, France, Italy, and the Netherlands have an average correlation coefficient above 0.70.
[44] These results cast doubt on the utility of dollarizing the Paraguayan economy.

Table 6.19. Business Cycle Comovements and Volatilities

Period	Argentina	Bolivia	Brazil	Chile	Uruguay	Paraguay	U.S.
Correlations with Paraguay							
1970–2000	0.0292	0.6101	0.1725	0.7166	0.6907	1.0000	–0.1259
1970–79	0.1349	0.3693	–0.1142	0.5190	0.8006	1.0000	0.4861
1980–89	–0.0105	0.9773	0.2608	0.8884	0.7367	1.0000	–0.2907
1990–2000	0.2640	0.6443	0.7302	0.7818	0.4793	1.0000	–0.5720
Standard Deviation							
1970–2000	0.0439	0.0348	0.0363	0.0617	0.0391	0.0473	0.0209
1970–79	0.0337	0.0344	0.0384	0.0719	0.0287	0.0341	0.0235
1980–89	0.0413	0.0443	0.0471	0.0764	0.0600	0.0719	0.0255
1990–2000	0.0555	0.0151	0.0234	0.0369	0.0182	0.0316	0.0142

Source: Authors´ estimates.

Figure 6.7. Ten-Year Rolling Correlation Coefficients with Paraguay

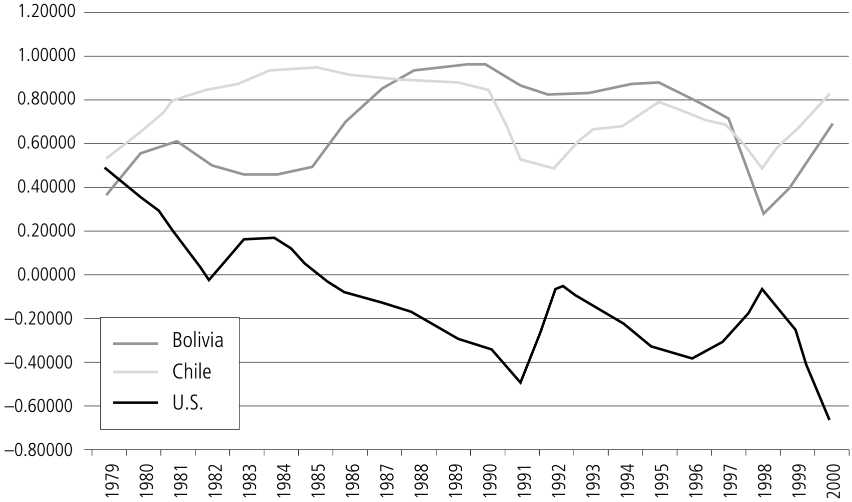


previously is that they reflect low comovement from earlier periods. Figures 6.7 and 6.8 illustrate the correlation coefficients between cyclical components compiled for rolling 10-year periods between the other countries and Paraguay. Similar findings are obtained for rolling periods of shorter length.

Figure 6.7 shows that comovements of output among the three full members of Mercosur and Paraguay follow similar patterns. In most cases, correlations tend to slightly fall from the initial periods of the sample through the early 1980s, when they recover somewhat. Then they all abruptly decline, in some cases even becoming negative at the beginning of the 1990s. With the beginning of the Mercosur area, the coefficients again rise until the end of the 1990s. Synchronization of cyclical output movements between Paraguay and these countries usually reaches its maximum at the end of this period. For example, during this decade the correlation coefficient with Argentina attains a value of 0.46 while the coefficient with Brazil reaches 0.82.

The coefficients with the other three countries in Figure 6.8 do not follow a common pattern. For the whole period, correlation coefficients with Bolivia and Chile fluctuate between 0.40 and almost 1. Note, however, that the correlation coefficient with the United States shows a clear tendency to decline over time, and it has a negative value after the mid-1980s.

Figure 6.8. Ten-Year Rolling Correlation Coefficients with Paraguay



These findings reinforce conclusions reached in earlier sections. Business cycle correlations with countries in the Mercosur area and the United States are not very high when considering the whole sample. However, disentangling the sample into 10-year subsamples reveals more commonality, especially with Bolivia, Brazil, and Chile.

Conclusions

This chapter has investigated the process of economic growth in Paraguay from the 1940s to the present, exploring a variety of dimensions relevant to understanding what has happened economically over time, particularly during the past 30 years. The picture that has emerged is not optimistic, and if the trends continue, Paraguay's future is bleak and the country will remain one of the poorest in the hemisphere.

This case study draws three main conclusions. First, total factor productivity of the economy has been on a declining (or at best a stagnant) path. So despite a significant accumulation of physical capital, income per capita has not grown. Second, Paraguay has failed to accumulate human capital. Paraguay has been left behind the rest of the region, as poverty statistics vividly show. Third, analysis confirms the importance of macroeconomic stability and of aggregate fluctuations with the country's main trading partners. Periods of macroeconomic stability have been associated with higher growth. Furthermore, the data show an increase over time in the importance of fluctuations with some of the country's trading partners, especially Brazil.

We believe that the first two findings, lack of productivity growth and human capital accumulation, stem from a highly inoperative public sector. It is important to highlight this point since the (relatively) small size of Paraguay's public sector is perhaps the most distinguishing feature of this economy in the context of Latin America. As any relevant theory of economic growth would predict, low taxes, especially on capital, are likely to foster growth. However, infrastructure investments can radically determine the rate of return of private investment. We believe that the Paraguayan government's provision of public investment has been subpar.

A similar assessment can be made in regard to the accumulation of human capital. There are numerous reasons to believe that unregulated markets would underperform in providing sufficient quality primary schooling, which is merely the first step in amassing human capital and building productive skills. Given the public sector's deficiencies in providing primary and secondary education, the country's failure to take off economically is unsurprising. And since human capital is complementary to physical capital, failure to accumulate it necessarily impairs the accumulation of physical capital.

Improving the accumulation of infrastructure and human capital requires Paraguay's government to take a pivotal role in the future. To that end, tax collection needs to be improved. But even if this happens, the country may be unable to lift itself up without assistance from the international community.

As to the relevance of macroeconomic stability, the lessons are in line with the current consensus so there is no need to elaborate them further. As for the greater interdependence with the Brazilian economy, this may simply be the outcome of natural advantages in geographical, historical, and cultural proximity that Paraguay is definitely wise to exploit. Even so, and despite the built-in static gains from these localized advantages, Paraguay would still benefit greatly in terms of growth and stability if it reduces any existent biases in trade and investment with the rest of the world.

Appendix 6.A

Incentives to Accumulate Capital

Paraguay's tax-GDP ratio has usually been among the lowest in the hemisphere, generally below 10 percent since 1971. Despite the positive implications of a smaller tax burden for the private sector, the corollary reduced volume of public sector income also had drawbacks: public sector wages typically were low, encouraging corruption; investment in standard public sector areas such as transport, basic health, and education has been limited; and social expenditures benefiting the poor were low.

In 1992 a significant and long-overdue tax reform was implemented. The previous tax system was hobbled by a proliferation of legal norms and an immense quantity of taxes and tax rates, creating a body of tax law that was complex, confusing, and unwieldy.[45] Among its most salient features were the following:

- Indirect taxes predominated, usually responding to partial fiscal needs.
- The system was regressive and complex, encouraging fiscal evasion and undermining the credibility of the agency administering taxes.
- Tax exonerations and special regimes were prolific.
- Custom tariffs were in force that discouraged a policy of openness and integration.
- Administrative bureaucracy provided incentives for the infringement of tax laws by evaders.

[45] Multilateral organizations characterized Paraguay's pre-1992 tax system as antiquated, inefficient, and unable to keep pace with domestic inflation and growth, thereby endangering macroeconomic equilibrium, future growth, and prospects for eradicating poverty.

Table 6.A.1. Paraguay's Tax Revenues as a Percentage of GDP (1970–2000)

1970	**1973**	**1975**	**1978**	**1980**
10.3	8.0	8.1	9.4	8.4
1983	**1985**	**1988**	**1990**	**1993**
6.4	6.9	6.9	9.0	8.5
1995	**1998**	**2000**		
10.0	10.6	9.9		

Source: Central Bank of Paraguay.

Before 1992, taxes could be classified into four broad categories: taxes on goods and services, income taxes, taxes on capital, and foreign trade taxes (Table 6.A.2). The first category grouped sales taxes, several selective consumption taxes (on fuel, liquor, cigarettes, livestock, etc.), stamp taxes on different kinds of transactions, and several other small taxes. Their total revenue represented 4.2 to 4.3 percent of GDP in 1984–88.

The tax structure on goods and services changed over time. The general sales tax totaled 0.6 percent of GDP in 1984, rising to 0.8 percent by 1987. Though exemptions were common and potential revenues difficult to calculate, evasion must have been high since the tax rate was 4 percent on domestic sales and 8 percent or 14 percent on imports, with 80 percent of the proceeds coming from the latter two.[46] The domestic sales tax only applied to the final consumer. Even if it affected only half of GDP, it should have raised more than 2 percent of GDP, more than twice the revenues actually collected. Although selective consumption taxes and stamp taxes fell under this heading, they were a grab bag of often unrelated fees. For example, the stamp tax included 84 different charges on civil and commercial dealings. Many were specific and thus declined in importance with inflation. Potential tax revenues also eroded through widespread exemptions.

The second broad category was also a collection of uncoordinated small taxes. Enterprises bore the brunt of income taxes since the personal tax was narrow and had negligible effect. The tax on profits (agriculture

[46] Therefore the sales tax was basically an import tax.

Table 6.A.2. Pre-reform Taxes as a Percentage of GDP (1984–90)

	1984	1986	1988	1990
Taxes on goods and services	4.21	4.18	4.30	4.61
Consumption	2.26	2.40	2.30	2.21
General taxes	0.56	0.74	0.81	0.78
Selective taxes	1.70	1.66	1.49	1.43
Stamp taxes	1.79	1.65	1.90	2.34
Other	0.16	0.13	0.10	0.06
Income taxes	1.11	1.25	1.42	1.26
Capital taxes	0.38	0.38	0.28	0.27
Land/property	0.35	0.35	0.25	0.27
Other	0.03	0.03	0.03	0.00
Other taxes[a]	1.01	1.01	1.02	3.08
Total tax revenue	6.71	6.82	7.02	9.22

Source: Central Bank of Paraguay.
[a] Mostly import and export taxes.

was exempted) was slightly progressive, with a bottom rate of 25 percent and a top rate of 30 percent. Income taxes represented 1.6 to 1.7 percent of GDP in the early 1980s, dropping to 1.2 percent in 1984–86 where they roughly remained in 1990. Evasion also must have been pervasive in this category. With returns to capital amounting to about half of value added and assuming that the tax applied to half of GDP, the enterprise tax alone should have represented 6.5 percent of GDP, over five times the actual collection. It must be mentioned, however, that an Investment Incentives Law was enacted in 1990 that gave beneficiaries five-year tax holidays on 95 percent of income taxes and six months of duty-free imports.

Capital taxes, the third category, generated little revenue, about 3 percent of total taxes and less than 0.3 percent of GDP in 1990. Although tax rates were about 1 percent of property value, assessments were extremely low. On average, urban property tax values represented less than 35 percent of market value while rural rates were only 5 percent. The capital tax category also included an easily evaded inheritance tax whose proceeds were insignificant.

Finally, Paraguay operated during this period with tariffs that were low and quite homogeneous despite customs law that implied wide dispersion and rates from 30 percent to sometimes above 70 percent. Three factors helped keep actual tariffs homogeneous and low. First, simple special regimes with low flat rates replaced many ordinary tariffs. Second, taxes close to 5 percent of import values often were charged under different rubrics so that some taxes were paid even on tariff-free goods. And third, unregistered imports set a rate ceiling. If tariffs exceeded 10 to 15 percent, goods tended to be imported through informal channels.

As mentioned above, taxes were widely evaded during this period because of what the private sector considered to be unreasonably high rates: 30 percent on profits, some high import tariffs, and the stamp tax (an inefficient scheme levying contracts rather than output, income, or wealth). The private sector evolved a complex "parallel economy" to avoid payments, with surprisingly favorable results relative to the "formal economies" in neighboring countries. Additionally, sanctions for missing tax deadlines varied by tax and often did not exist. The system was rife with disincentives. When penalty interest rates were levied, they usually were lower than commercial rates, making it more profitable for the taxpayer to delay payment until the infraction was discovered (if it ever was).

In 1992, the authorities proposed a plan to reduce the number of taxes while making the system simpler and easier to manage (Table 6.A.3). It basically (1) replaced the stamp tax and a myriad of small, hard-to-collect, indirect taxes with a value-added tax and a few ad valorem taxes on consumption of fuels, liquors, cigarettes, luxuries, and so on; (2) enacted a direct and indirect "sole" tax on small businesses, replacing all direct and indirect taxes previously applicable;[47] (3) increased the profits tax by dropping the bottom tier of the previous system and adopting the top tier as a flat rate; (4) enacted an income tax on agriculture property, using the presumptive income concept; and (5) put teeth in the penalty system to truly fight late payments and evasion. Other reforms included proper assessment of property values and abolition of the inheritance tax.

The tariff regime improved substantially after the reform, and central government revenues increased rapidly during the 1990s, reaching about

[47] Small enterprises were exempt from charging the value-added tax to their customers. Additionally, they were allowed to deduct from the new "sole" tax half the value-added taxes they paid for inputs.

Table 6.A.3. Post-reform Taxes as a Percentage of GDP (1995–2001)

	1995	1997	1999	2001
Income taxes	2.3	2.1	2.3	1.5
Taxes on goods and services	6.1	6.3	6.0	6.4
Excise taxes	1.2	1.3	1.3	1.9
Value-added tax	4.4	4.5	4.3	4.1
Stamp tax	0.4	0.4	0.3	0.3
Other	0.2	0.1	0.1	0.2
International transaction taxes	2.8	2.3	1.7	1.7
Import duties	2.8	2.3	1.7	1.7
Total tax revenue	11.2	10.7	9.9	9.6

Source: Central Bank of Paraguay.

10 percent of GDP. Most of the increase was due to import taxes and the introduction of a value-added tax (VAT) of 10 percent. Import taxes, which today account for some 20 percent of tax revenue, rose from 0.9 percent of GDP before reform to 2.8 percent in 1995, falling slightly to 1.7 percent in 2001. Meanwhile the VAT accounted for 4.4 percent of GDP in 1995 and 4.1 percent in 2001. Income taxes and selective excise taxes also were important. Somewhat surprisingly, Paraguay collected revenues worth 10 percent of GDP despite a relatively low tax burden and few forms of taxation: a 10 percent VAT, low import tariffs, no personal income tax, and a 30 percent corporate income tax with many exceptions.

It must be mentioned that in ratifying the Treaty of Asunción in July 1991, Paraguay agreed to an automatic schedule of tariff reductions and a reduced list of exceptions so as to become part of the Mercosur free-trade zone. Paraguay then replaced the 1991 tariff schedule in July 1992 with a new schedule of even lower and more homogeneous rates and instituted an import VAT. The changes left tariff positions—not including lists of exceptions and internal consumption taxes—at 0 percent for inputs, 5 percent for capital goods, 10 percent for final goods, and 15 percent and 20 percent for cars.[48] The uniform import VAT was set at 10 percent. The net effect brought the tariff code more in line with the de facto openness of the economy.

[48] The tariff simplification eliminated all special regimes and exceptions.

In summary, tax and external tariff distortions to accumulate capital do not seem to have been important during the whole period. Tax evasion, special tax and tariff regimes, and smuggling substantially reduced the tax burden of the private sector before 1992. After the tax reform, the tax-GDP ratio remained among the lowest in the region even though the reform was expected initially to yield higher revenues. It is well known that investment incentives such as tax exemptions, subsidies, and other benefits can be important, without being crucial, in attracting private capital. Paraguay seems a case in point. Its Investment Incentives Law provided better incentives than laws in many Latin American countries without being able to attract large flows of private capital.

As several authors agree, a country's credibility in maintaining stable long-term policies is vital to attracting private capital. Insfrán Pelozo (2001) says this credibility depends on restraining the government's ability to change the rules of the game with respect to restrictions on capital movements, taxes, property rights, risk of expropriation, nonconvertibility of local currency, civil wars, and so on. Barro (1991) and De Gregorio and Lee (this volume) cite the rule of law and the quality of political institutions as important factors explaining growth rates across countries. They argue that an institutional environment with a strong legal system that secures property rights is central for investment and other economic activities. Further examination of these alternative factors may shed light on why growth and investment have been so low in Paraguay.

Appendix 6.B

Graphs for Growth and Other Main Macro Variables

Figure 6.B.1.A. Inflation and Growth, Unfiltered Data

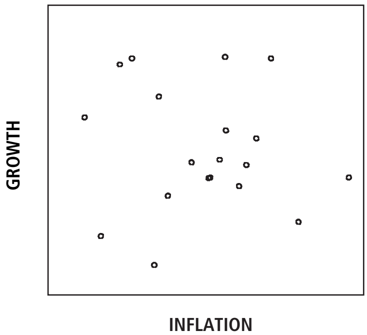


Figure 6.B.1.B. Inflation and Growth, Filtered Data

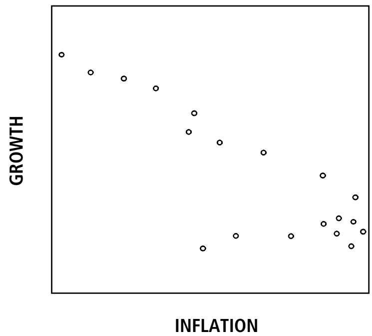


Figure 6.B.2.A. Gov. Cons/GDP, Unfiltered Data

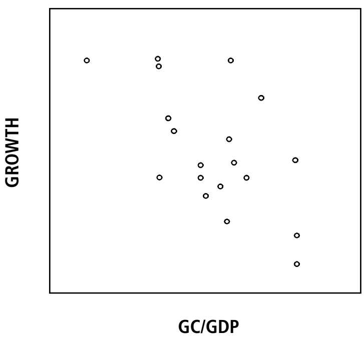


Figure 6.B.2.B. Gov. Cons/GDP, Filtered Data

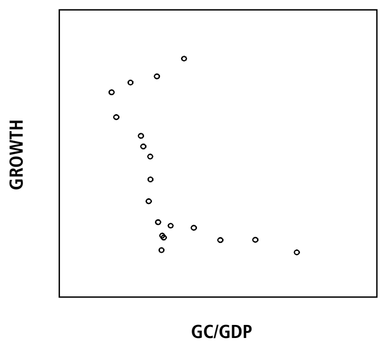


Figure 6.B.3.A. Change in (Gov. Cons./GDP), Unfiltered Data

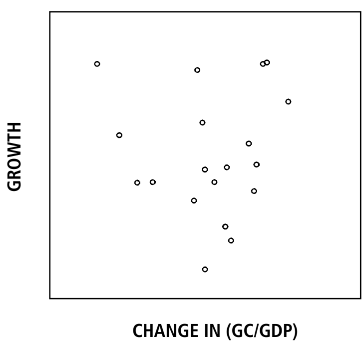


Figure 6.B.3.B. Change in (Gov. Cons./GDP), Filtered Data

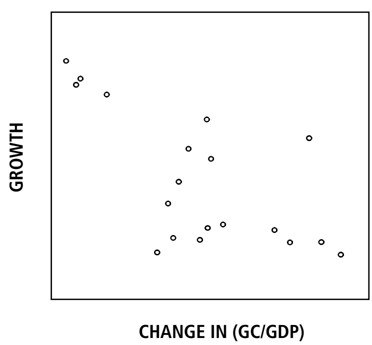


Figure 6.B.4.A. Private Cons/GDP, Unfiltered Data

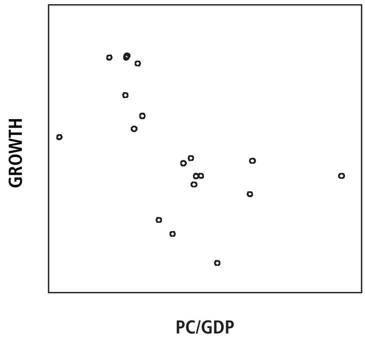


Figure 6.B.4.B. Private Cons/GDP, Filtered Data

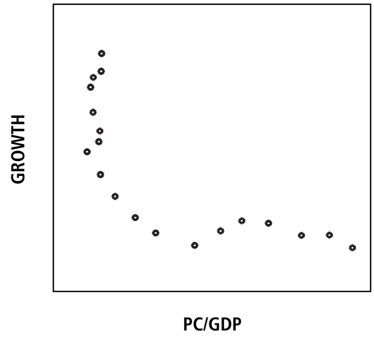


Figure 6.B.5.A. Change in (Private Cons/GDP), Unfiltered Data

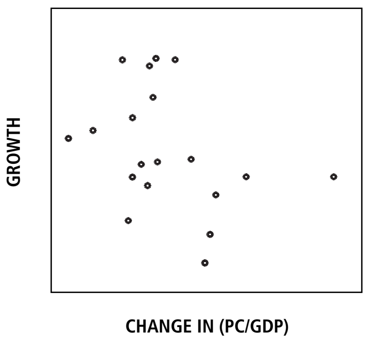


Figure 6.B.5.B. Change in (Private Cons/GDP), Filtered Data

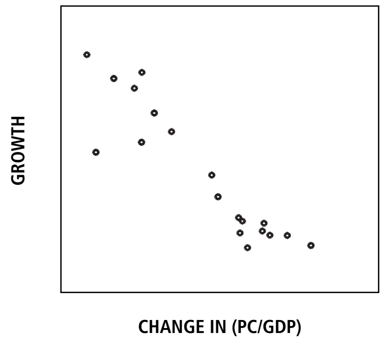


Figure 6.B.6.A. Investment/GDP, Unfiltered Data

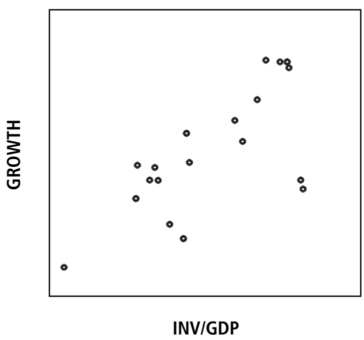


Figure 6.B.6.B. Investment/GDP, Filtered Data

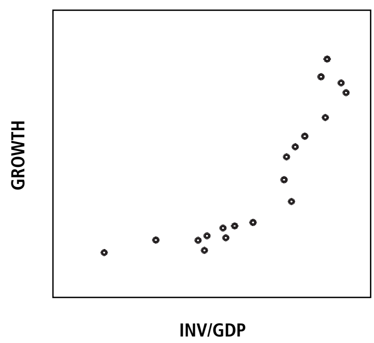


Figure 6.B.7.A. Terms of Trade, Unfiltered Data

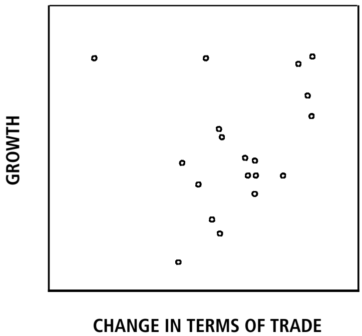


Figure 6.B.7.B. Terms of Trade, Filtered Data

Figure 6.B.8.A. Exports, Unfiltered Data

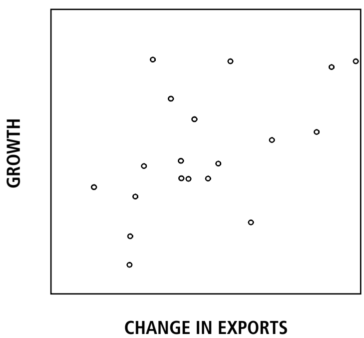
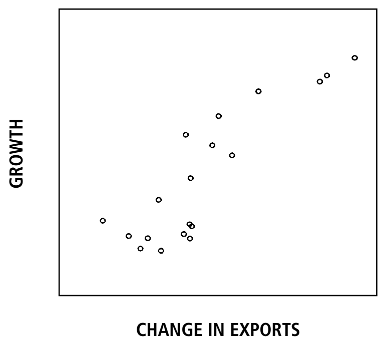


Figure 6.B.8.B. Exports, Filtered Data



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CHAPTER 7

Markets, Government, and the Sources of Growth in Peru

Eliana Carranza, Jorge Fernández-Baca, and Eduardo Morón[1]

The sour taste of recent history in most of Latin America lingers on, challenging the old saying that the "past is always sweeter." Many countries entered the new millennium with an acute sense of disappointment, having almost the same per capita incomes they had in the early 1950s. Peru is no exception to the rule. As the main character in one of Mario Vargas Llosa's best-known novels puts it, the only question is, "When exactly did Peru screw up?"[2]

The disappointment has been particularly acute in Peru because promising hopes have been dashed. Since the first half of the 1960s, the Peruvian economy has regressed from being one of the most promising among developing countries, in terms of both growth and social progress. It is true that the average income in Peru at the time, in terms of gross domestic product (GDP) per capita, was only one-tenth of that in the United States, and well below that in Latin American countries like Argentina and Uruguay. However, it was equivalent to 45 percent of Japan's GDP per capita and 3.5 times greater than South Korea's. Yet by 1999, according to the World Bank, Peru's average income was roughly 6 percent of per capita GDP in the United States

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[2] Zavalita, in Mario Vargas Llosa's 1969 novel *Conversación en la Catedral*, asks, "¿En qué momento se había jodido el Perú?"

and Japan, and 25 percent of South Korea's. While the United States had grown 68 percent faster than Peru, in per capita terms, between 1965 and 1999, Japan and Korea had outstripped Peru's growth rate by 6 and 12.5 times, respectively. Today Peru is struggling to find a new path to sustained growth.

This study begins, then, with the question of what has gone wrong with the Peruvian economy during the last 40 years to cause it to perform so badly. The economy not only was unable to maintain the 3 percent annual growth rate in 1950–65 GDP per capita—a bit above the Latin American average of 2.3 percent—but it entered a long decline, contracting at a yearly rate of 0.8 percent between 1966 and 1990. If Peru had only kept pace with the yearly world average of 2 percent, GDP per capita at the end of 2000 would have been 90 percent higher than it was.

A second question is why Peru failed to take advantage of its resource base. Despite a relatively large supply of natural resources (minerals, fishing, forests, and fertile coastal valleys) and a stock of human capital in 1960 that was superior to that in most of East Asia, except Japan, it has been unable to find a path to sustainable high growth like other countries, especially in Southeast Asia. Certainly it wasn't for lack of trying: Peru has experimented during this time with nearly the whole range of market economic policies.

Peruvian governments have moved from an extreme view of the ECLAC recipe for protectionism and pro-Keynesian, activist fiscal and monetary policies under General Velasco (1968–75) and President García (1985–90) to free-trade and nonactivist policies under Presidents Belaúnde (1980–85) and Fujimori (1990–2000). This acute and pervasive whipsawing in policy may, in fact, be a large part of the answer to the question of failed growth.

The chapter is organized as follows. In the first section we present some empirical regularities of the growth process in Peru. In the second section we discuss the quality and availability of the data used. In the third section we perform a standard growth accounting exercise. In the fourth section we evaluate Pritchett's claim that most public investment is overvalued and therefore distorts TFP calculations. In the fifth section we attempt to explain TFP growth. Finally, the sixth section presents our conclusions.

An Empirical Overview of the Economy

According to the data for 1896–1995 (Seminario and Beltrán, 1998) and the extended data through 2000 (Seminario, 2001), the Peruvian economy grew at a relatively stable pace between 1896 and 1965, interrupted by brief periods of crisis in 1930–33, 1942, 1947, and 1958–59 caused by foreign demand shocks (Figure 7.1). The average yearly growth of per capita GDP was 2.7 percent for 1896–1965, with a slight upward tick toward the end of the period (to 2.9 percent for 1946–65 from 2.4 percent for 1896–1945).

Since 1966 the Peruvian economy has been in decline, with an initial gradual slowdown in the rate of growth turning into a frank deterioration. After growing at an average yearly rate of 1.5 percent for 1966–75, GDP per capita declined at an annual rate of –2.2 percent between 1976 and 1990. For the whole 1966–90 period, GDP per capita deteriorated at a yearly rate of 0.8 percent. Finally the Peruvian economy in 1990 ended two decades of stagnation and embarked on a new path of growth that lasted until the 1998 financial crisis. GDP per capita grew at a yearly rate of 3.9 percent from 1991 to 1997, before falling to only 0.3 percent between 1998 and 2000.

Figure 7.1. Evolution of Per Capita GDP and Yearly Growth Rates (1896–1999)

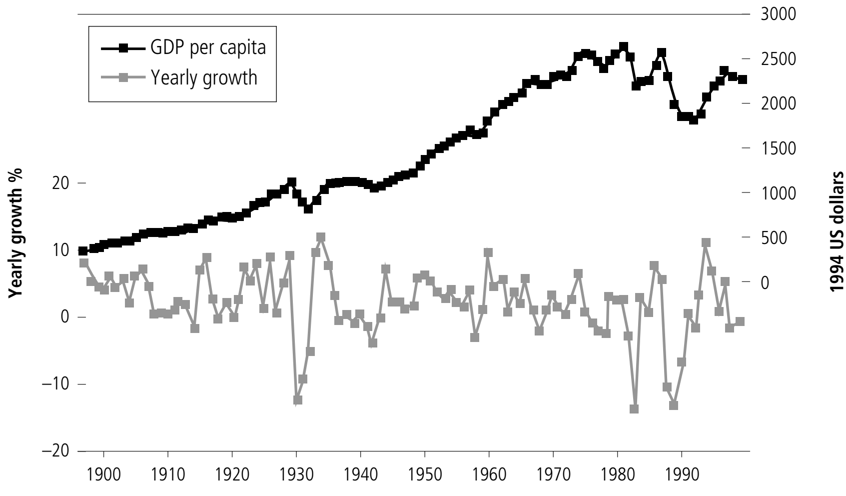
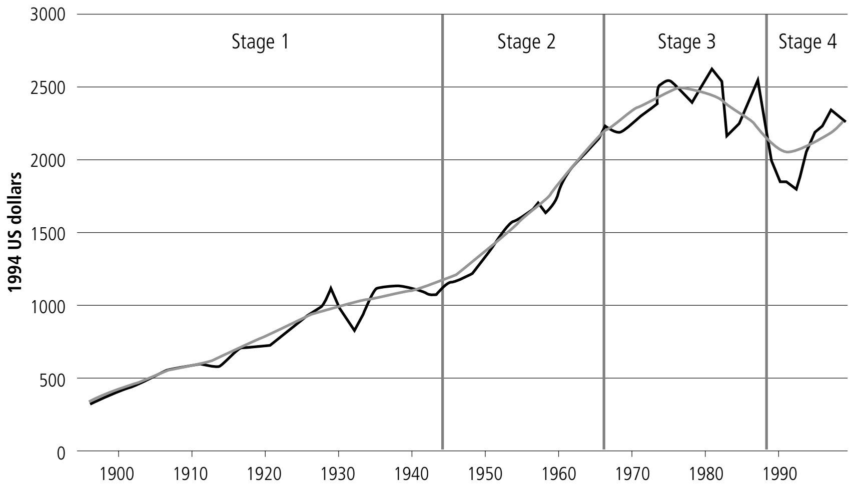


Figure 7.2. Stages in Peruvian Economic Development (1896–2000)



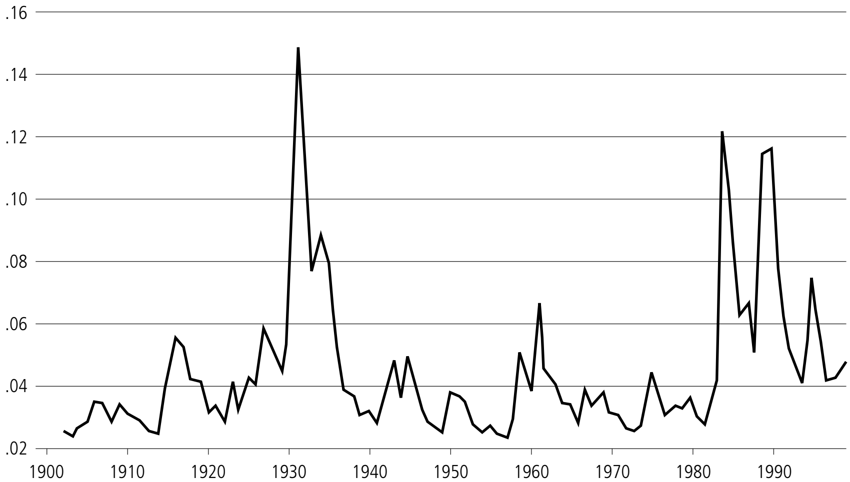
As Figure 7.2 indicates, the Peruvian economy can be briefly summarized in four stages during the twentieth century.[3] The end of the Second World War in roughly 1945 marks the close of a first period of moderate growth, and the beginning of a second and a much more vigorous period of economic activity that lasts until the mid-1960s. The third stage of economic decay and high inflation lasts from 1966 to 1990. This is followed by a fourth period whose main feature is revival of economic growth.

From figures 7.1 and 7.2, it is apparent that the 1900–80 period looks a lot more stable than the 1980–2000 period. Indeed, if we run a GARCH model of the variance of GDP per capita we find that the period since 1980 has been much more volatile than the previous 70 years, once we take out the effect of the Great Depression (see figure 7.3).

One question that arises from this fact is whether this increasing volatility is purely exogenous or is endogenously explained by policy decisions. One could expect that in the case of a commodity exporter economy that is constantly buffeted by terms-of-trade shocks, GDP will fluctuate

[3] We deliberately chose not to identify the stages by statistical means. However, in Appendix 7.B, we present statistical evidence supporting the subperiods chosen.

Figure 7.3. Conditional Variance of GDP Per Capita (1900–2000)



accordingly. It is important to recall that one of the characteristics of Peruvian exports were their diversity. This allowed the economy to withstand commodity-specific external shocks.

However, the potential sources of volatility are much larger than just the terms of trade. Policies, world interest rates, availability of external financing, and the way crises are managed are all factors that might be equally important to or even more important than just the terms of trade.

Table 7.1 briefly describes the data underpinning how the economy and economic policies have evolved since 1950, when the central bank began to estimate the national accounts. This table clearly shows a first phase of sustained economic growth from 1950 to 1965, coinciding with a period of free markets and export-oriented economic policies with a very small footmark by the public sector in total consumption and investment. These policies were hallmarks of the Odria and Prado governments, as well as the Junta Militar that ruled in 1962–63. Table 7.1 shows a growing ratio of exports to GDP, a relatively high ratio of investment (which, however, started declining sometime during 1961–65), a low fiscal deficit, and a high private sector share in total investment. GDP per capita during this period grew at an average yearly rate of 2.8 percent, while annual inflation

Table 7.1. Primary Macroeconomic Growth Rate Indicators for Peru (1951–2000)

Periods	GDP per capita	Exports/ GDP	Gross fixed investment/ GDP	Private sector share in gross fixed investment	Fiscal superavit (deficit)/ GDP	Inflation rate (yearly average)
1951–55	3.02	11.58	21.32	77.52	0.48	9.36
1956–60	2.59	13.25	20.79	79.18	–0.43	10.76
1961–65	2.88	14.75	18.14	73.66	–0.74	11.28
1966–68	–0.74	13.86	17.58	63.05	–2.30	14.48
1969–75	2.28	11.62	18.37	56.44	–2.52	11.28
1978–80	0.20	11.88	18.71	64.41	–3.91	55.29
1981–85	–3.59	12.15	19.55	68.39	–4.10	111.99
1986–90	–6.55	10.12	16.34	77.96	–5.53	1294.43
1991–95	4.51	12.27	19.56	77.68	–3.30	37.22
1996–2000	0.77	14.90	22.35	80.42	–1.83	5.73

Note: Rates are expressed as percentages.

was around 10 percent, one of the lowest rates for Latin America at the time.

In 1966 the Peruvian economy entered a second phase, a general economic decline that lasted nearly a quarter century. This phase coincides with a succession of governments espousing interventionist and protectionist economic policies, beginning with Belaúnde's first term in 1963 and ending with García in 1990. Although Belaúnde's populist measures began at the tail end of the first period, their consequences became visible only at the outset of the second, with high fiscal and balance-of-payment deficits in 1966 that eventually forced the central bank to devalue the sol by 45 percent in 1967. Belaúnde was overthrown in 1968 by a socialist-oriented military junta led by General Velasco, which intended to replace the private sector with state-owned enterprises, cooperatives, and other kinds of labor-managed enterprises.

Velasco's drive to complete his reforms led the economy into a profound economic crisis, creating huge deficits in the fiscal budget and the balance of payments. During this period most foreign firms were nationalized and private capital was banned from the agriculture and fishing sectors, as well as in public utilities. Most foodstuffs were subject to price controls, and severe restrictions were applied to the foreign exchange market and foreign trade. The economic crisis that followed incited an internal rebellion under General Morales Bermúdez, who finally replaced Velasco in 1975. Morales Bermúdez's government did much to remedy the huge inherited economic imbalances. However, the new administrative reforms were targeted macroeconomically, leaving the whole range of microeconomic distortions affecting incentives to save and invest almost untouched.

Table 7.1 shows the private sector's share in total investment declining between 1966 and 1980, striking bottom during Velasco's administration of 1969–75. During the same 1966–80 time frame the ratio of exports to GDP sharply deteriorated, as did the fiscal budget. It is thus no surprise to see GDP per capita remaining flat during the second half of the 1970s while the inflation rate was climbing relentlessly.

Not only did the Peruvian economy not recover during the 1980s, it plunged into its worst crisis of the twentieth century. Although Belaúnde's second term introduced adjustments such as liberalizing the current accounts and capital accounts and eliminating price controls, his administration was unable to privatize the huge sector of state-owned enterprises or eliminate job stability laws and other regulations affecting investment incentives. The few reforms Belaúnde introduced were then dismantled by García, who in 1985 tried to resuscitate the spirit of Velasco's government. Naturally García's administration ended with a colossal fiscal deficit, which reached 8 percent of total GDP between 1987 and the first half of 1990.[4] It was accompanied by an astounding inflation rate above 1,000 percent during three consecutive years (1988–90). The ratio of exports to total GDP plummeted to its lowest level, and GDP per capita, which had already declined by 3.6 percent yearly under Belaúnde, fell even faster—at a rate of 6.6 percent—under García.

In 1990 a new phase began with the reforms implemented by the Fujimori administration. These reforms removed nearly all the obstacles

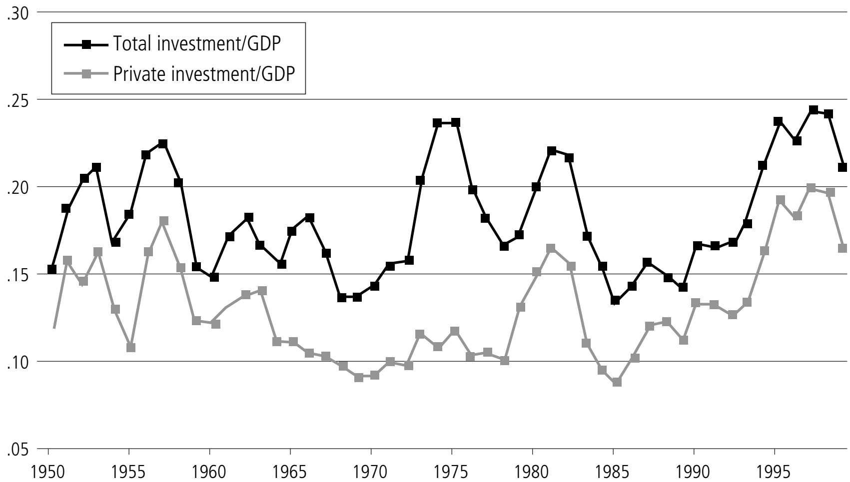
[4] This comprises the deficit of the whole public sector, that is, the central government (including social security and municipalities) and state-owned enterprises.

to private investment introduced during the Velasco and García administrations. A vast privatization program was implemented, along with a redefinition of public sector intervention in the Peruvian economy. Table 7.1 shows the ratio of exports to GDP increasing during this period, along with the investment ratio and a robust private sector share of total investment, while the fiscal deficit and inflation were declining dramatically. As a consequence of these reforms, the Peruvian economy entered a new path of sustained economic growth, expanding by 3.9 percent yearly between 1991 and 1997. This blissful period ended in 1998 when the international financial crisis showed that some urgent reforms still needed to be implemented.

Now that we know when the Peruvian economy "screwed up," let's try to see why it happened. Fernández-Baca and Seinfeld (1995) estimated a Solow's neutral progress model for the Peruvian economy and found that one-third of the 2.8 percent average per capita GDP growth for 1950–68 was explained by the accumulation of physical capital, while the remaining two-thirds was explained by technological progress. In contrast there was negative technological progress during the following 22 years (1969–90), with a yearly decay of –1.5 percent in total factor productivity (TFP) that explains the 1.2 percent annual decline in GDP per capita. Quite surprisingly, the capital-output ratio (K/Y) showed a slight increase from 2.8 to 3.1 during the first period (1950–68) and almost doubled during the second (1968–90), rising from 3.1 to 5.9.

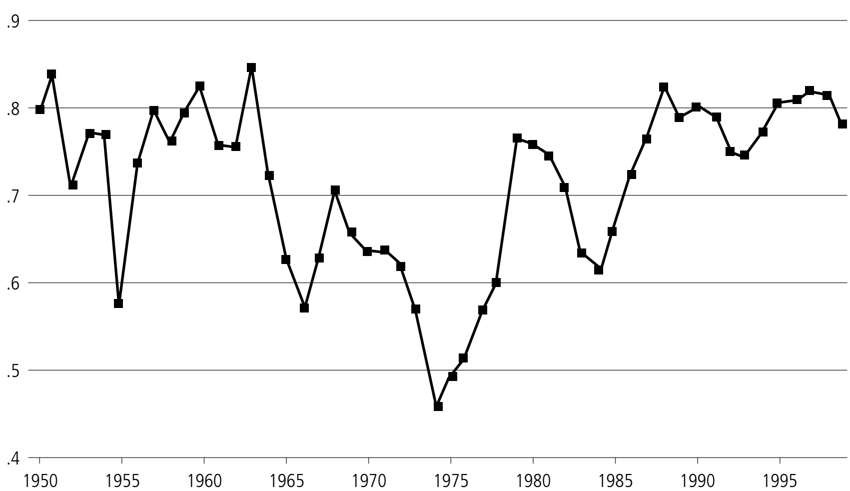
Despite all the criticism addressed generally to Solow's model, this naïve calculation does show that something has gone wrong with an economy in which the total capital stock increased twice as fast as GDP. This seems to be connected with the decay of private investment that started in the second half of the 1960s, was temporarily reversed in the second half of the 1970s, and was definitively overcome in the 1990s. As Figure 7.4 shows, total investment as a percentage of GDP increased during the 1970s while private investment declined. It was only in the 1990s that the ratio of private investment to GDP recovered to the levels it had attained during the 1950s and the first half of the 1960s.

Figure 7.4. Total and Private Investment as Shares of GDP (1950–98)



This contrast between the evolution of private and total investment is explained by growing public investment in state-owned enterprises. Figure 7.5 shows that private investment between 1950 and 1965 accounted

Figure 7.5. Private Investment as a Share of Total Investment (1950–98)



for nearly 90 percent of total investment. Its relative importance began to decline during the second half of the 1960s, reaching a floor of 63 percent in 1974. After a temporary recovery between 1975 and 1978, it found a definitively stable level of around 80 percent in the 1990s.

Perhaps the easiest way to understand how the incentives to invest have changed during the last 40 years is to relate the behavior of the ratio of physical capital to human capital to its relative prices. As we do not have good proxies for the relative price of capital with respect to labor, and most of the physical capital is imported, we use the real exchange rate. The real exchange rate will be measuring the price of (tradable) capital relative to nontradables (wages, among others).

Although the relationship is not tight at the beginning of the sample, Figure 7.6 shows a very good fit for the last 25 years. What is important is that the relative prices were biased towards the accumulation of physical capital between 1960 and 1980. First, the liberalization process, and then, the collapse of the exchange rate regime changed completely the picture in the private sector. The other part of the story comes from a significant decrease in public expenditure (in particular, public investment) from 1975 onwards (see Figure 7.7).

Figure 7.6. Physical Capital to Human Capital Ratio and Real Exchange Rate

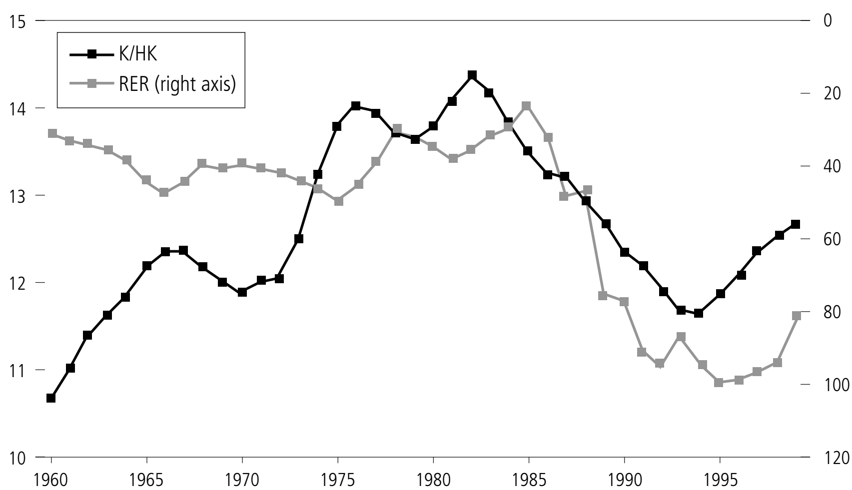
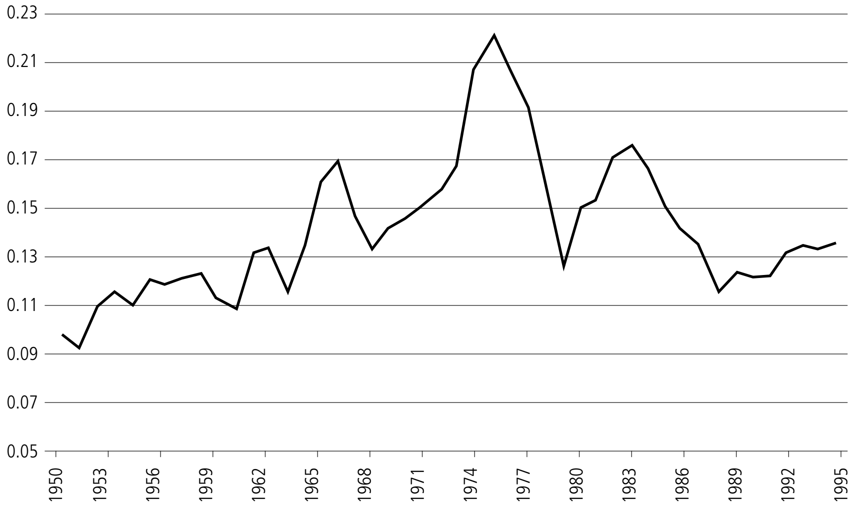


Figure 7.7. Public Expenditure
(percentage of GDP)

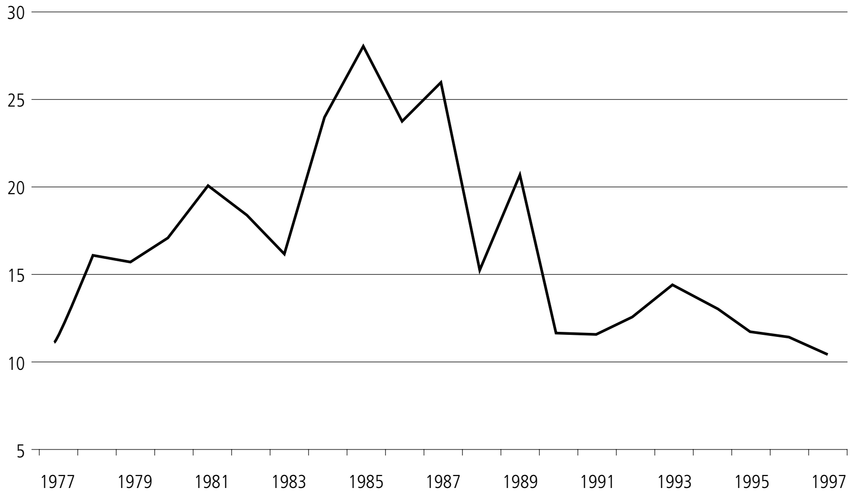


In addition it is important to mention that the level of effective protection changed quite substantially during this period. The liberalization process initiated at the beginning of the 1980s was reversed in 1983–84 as the economy went into a severe recession. GDP fell more than 12 percent, and the government decided to stop the process. Moreover, in the 1985–90 administration, import duties were raised and the list of prohibited items grew bigger as the crisis mounted. Therefore, part of the decrease in physical capital accumulation is also due to this reversal of the level of protection. In Figure 7.8 we show the behavior of a very poor proxy, the ratio of import duties to imports.

Data and Methodology

The data used in this study come from three main sources: (1) the World Bank Economic Growth Database (WB), (2) the Central Bank of Peru (BCRP), and (3) the National Institute of Statistics (INEI). A fourth source is private estimations constructed by Arlette Beltrán and Bruno Seminario (BS) from Universidad del Pacífico. This section highlights the process of constructing

Figure 7.8. Implicit Import Duties
(duties as a percentage of imports)



the main variables used in the growth accounting exercise. All variables are expressed in 1995 U.S. dollars and cover the period from 1950 to 1999.

GDP

A GDP series was constructed in 1995 dollars using data provided by BCRP, which was expressed in 1994 soles.[5]

Fixed Gross Investment

As previously, we used data from the BCRP. However, the first observations came from INEI since the other series was incomplete. We disaggregated these data in (a) construction and (b) machinery and equipment. Shares of these two types of investment as a percentage of GDP were similar in the WB and BS databases, but the level of GDP was overestimated. Therefore the series was adjusted according to the new GDP series that we constructed.

[5] The BCRP series are the only ones that include estimates using the new 1994 base.

Figure 7.9. Gross Domestic Product
(duties as a percentage of imports, US$ millions)

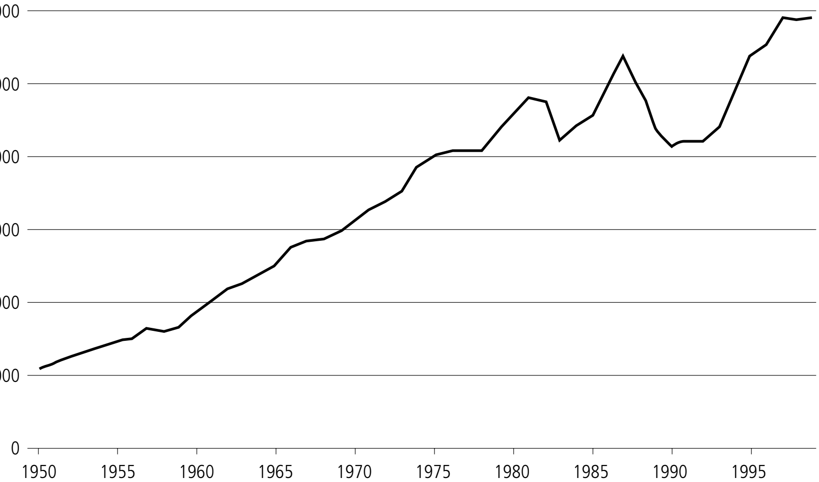
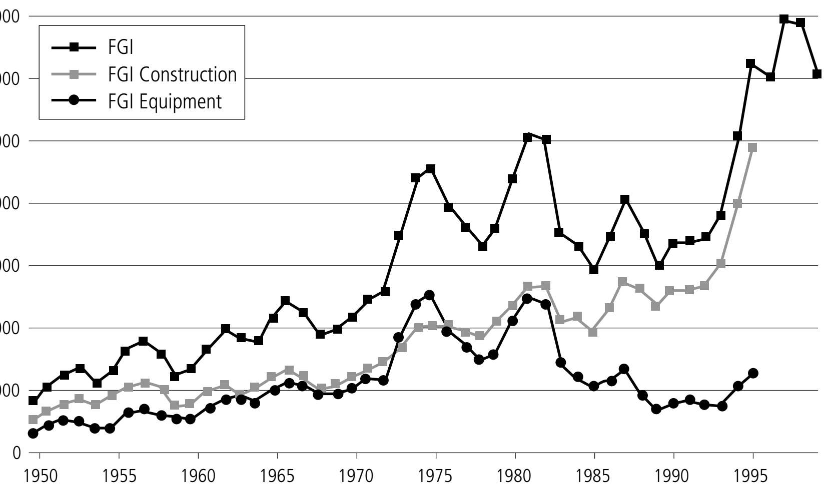


Figure 7.10. Fixed Gross Investment
(US$ millions)



Capital Stock

One major hurdle was the lack of an official series of capital stock for Peru. Nehru and Dhareshwar (1993) have estimated a capital stock series, which was later updated by Calvo and Bonilla (1998) and Fajnzylber and Lederman (1999). However, the three studies used an inadequate fixed investment series, rendering an overestimated capital stock.

We constructed an estimate using the method described in Nehru and Dhareshwar (1993) and applying our fixed gross investment series. The capital stock is estimated using the perpetual inventory method:

$$K_t = (1-\delta)^t K_0 + \sum_{i=0}^{t-1} (1-\delta)^i I_{t-i}, \qquad (7.1)$$

in which δ is the depreciation rate and K_0 is the initial capital stock.

We used a depreciation rate of 6 percent for machinery and equipment and 3.5 percent for construction.[6] The overall depreciation rate is 4.5 percent. These depreciation rates are within the limits of previous studies that go from 2.5 percent in Seminario and Beltrán (1998) to 7 percent in Vallejos and Valdivia (1999).

Our estimate for the initial capital stock came from the fact that in the steady state of the Solow growth model,

$$K_0 = I_1/(g+\delta), \qquad (7.2)$$

with g signifying the GDP growth rate.[7] The level of the initial capital stock does not bias the final result since once one moves back far enough in history (1900), the effect of the initial capital stock on current capital stock is almost negligible.

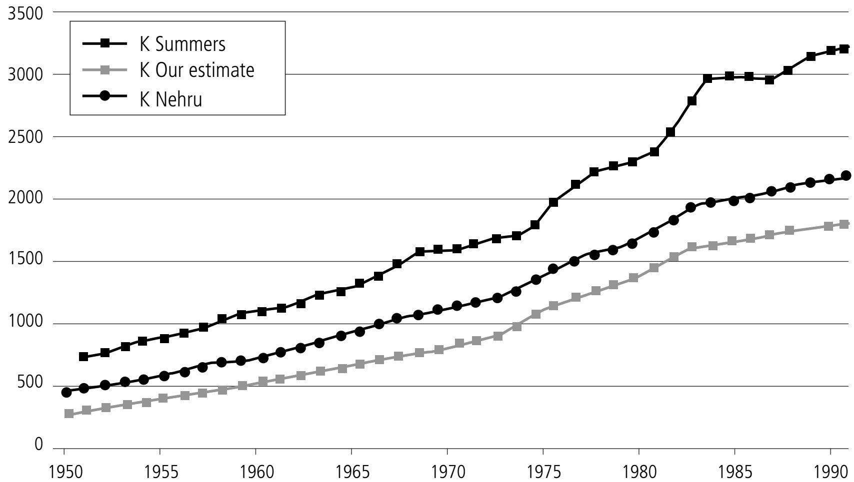
In Figure 7.11 we compare our estimated capital stock series with the Nehru and Heston and Summers data. Our estimates are in line with a recent study by IPE (2001) that also used the series with the new 1994 base.

To shed more light on what has happened with the capital stock series, we present estimates of machinery and equipment and of construction (Figure 7.12). Both components had similar trends until the 1980s.

[6] These rates imply a lifetime of 28.5 (16.66) years for construction (machinery and equipment). Disaggregated data on investment in machinery and equipment and construction are available only up to 1994.

[7] See Barro and Sala-i-Martin (1995) for a thorough explanation.

Figure 7.11. Capital Stock Series



Since then the capital in machinery and equipment has fallen while the trend in construction has been steeper. This could be explained by a larger governmental commitment to public infrastructure (roads, schools, housing projects, etc.) and by a real estate boom in the 1990s.

Figure 7.12. Our Disaggregated Capital Stock Series
(US$ millions)

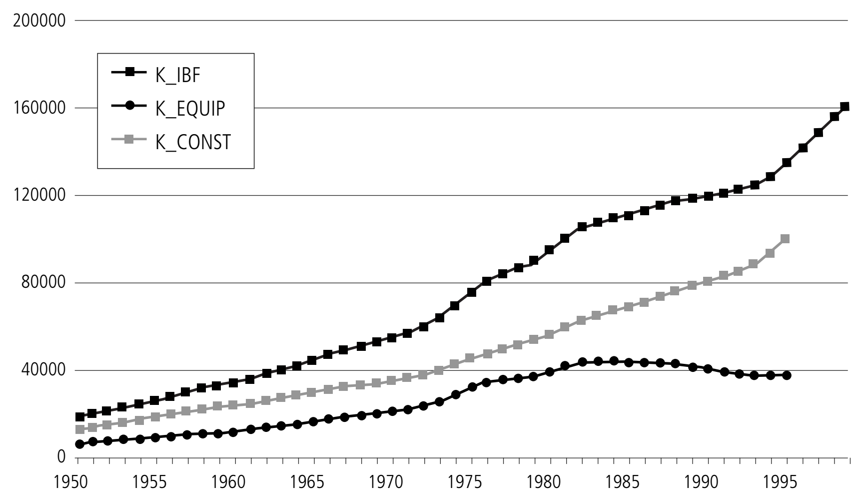
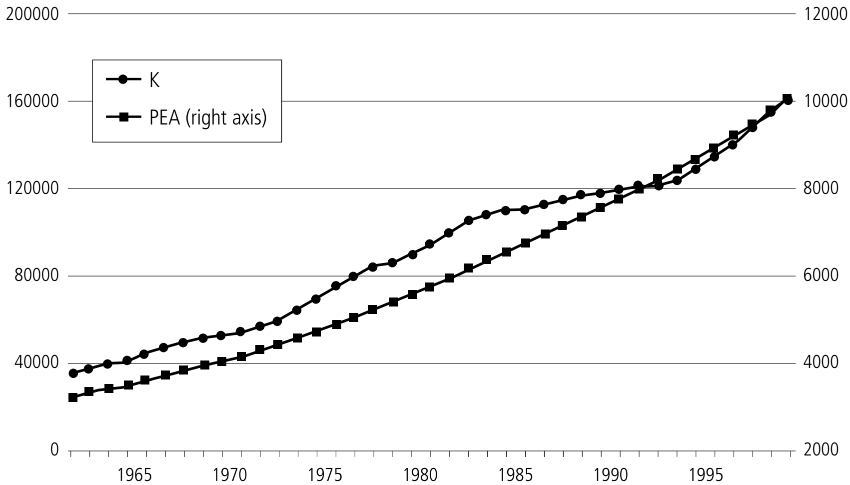


Figure 7.13. Labor Force and Capital Stock



Labor Force

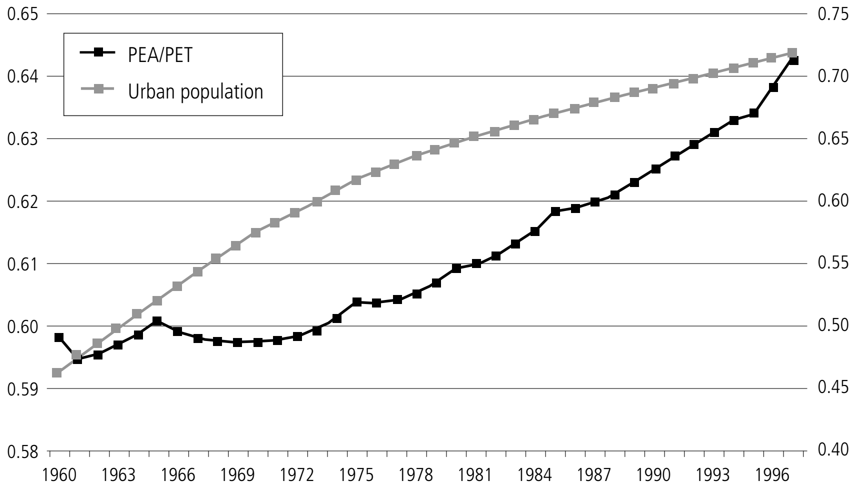
Due to lack of information about hours worked, we had to choose between the economically active population (PEA) and the number of workers, with the difference between these two series being the unemployed population. Although the number of workers more adequately approximates the number of hours worked, the official series is available only for the last decade. Therefore we chose to use the PEA, which is available for the whole sample with a greater degree of accuracy (Figure 7.13).

During the last 50 years, the average growth rate of the PEA was 2.8 percent. The rapid PEA growth is explained not only by an increase in population but also by a steady increase in the labor participation ratio since 1960 (Figure 7.14).[8] There are two interplaying factors.

The first driving force behind the increase in the labor participation ratio was the sustained migration toward urban areas. Movement to the country's main cities was promoted by General Velasco during the early 1970s and reinforced by the low returns on agricultural activities after the

[8] The labor participation ratio is computed as a ratio of the economically active population (PEA) to the population able to work due to their age (PET).

Figure 7.14. Labor Participation and Urban Population Ratios



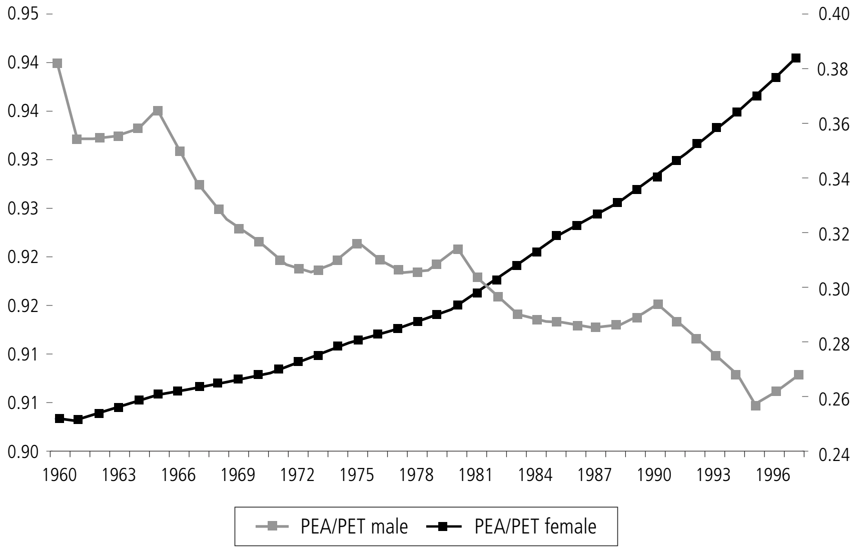
failed agrarian reform of the late 1960s. Once the rural population moved to urban areas it was forced to seek market activities to earn a living.

The second driving force has been the steady growth of the female participation ratio (Figure 7.15). This could be explained by both the need to earn a market wage once families relocated from the countryside to the city and the increase in job opportunities for women. The second factor has predominated since the 1980s.

One additional fact that calls for explanation is the small variability of the labor input compared to capital (Figure 7.13). The hours-worked series could fluctuate because firms adjust in the intensive/extensive margin. They could add an additional shift in the midst of an expansion, hiring more workers or asking their existing workforce to add extra hours. Only small fluctuations were observed in the extensive margin, but what happened in the intensive margin cannot be inferred from that. Furthermore, the information is inconclusive, since most of the labor market transitions are from employment to underemployment rather than unemployment.

Using the unemployment rate to adjust the PEA would have minimal impact. In Peru the unemployment rate is quite stable since not all informal workers are counted as unemployed in calculating the rate. Thus

Figure 7.15. Labor Participation Rates by Gender



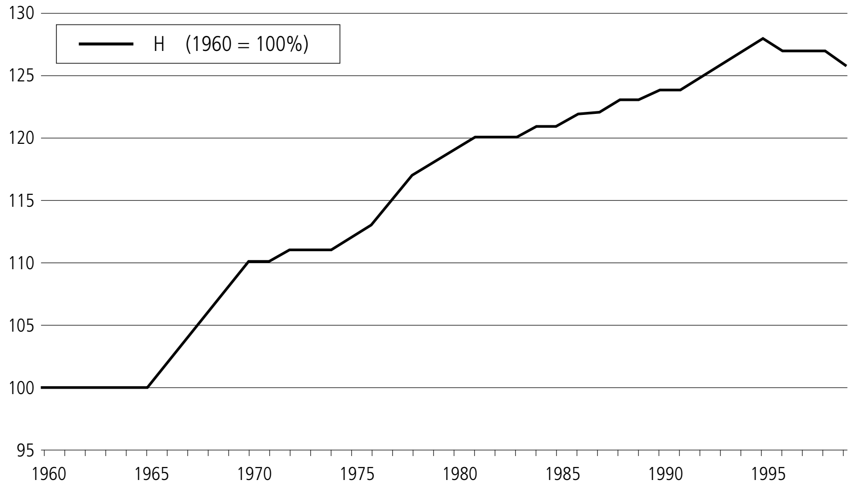
most of the cyclical variation in employment could be explained as movement from formal to informal jobs. In line with the lack of detailed data on labor markets, a separate measure of formal and informal workers is only available for the last five years, leaving the PEA figures as the best option.

Human Capital

There are two ways to measure labor force quality (Barro and Lee, 2000). First, one can adjust the labor force using the average years of schooling. Second, one can adjust by using the average wage for each educational level. The second method was impractical for this study. Even though there was information about the composition of the population older than the age of 15 (similar to the PEA), detailing education attainment level and the years of average schooling for each level and by gender, only 10 years of disaggregated data were available. Therefore the first method was used to compute an index of average years of schooling in the labor force.

One immediately notices the decreasing growth rate of the human capital index during the last 30 years. Moreover, since 1995 the index has

Figure 7.16. Human Capital Quality Index



fallen for the first time. This should not be surprising since the educational expenditure per capita has shown a downtrend since the late 1960s (Figure 7.17). Only in the 1990s was the trend reversed, surprisingly coinciding with the decline in the human capital index.

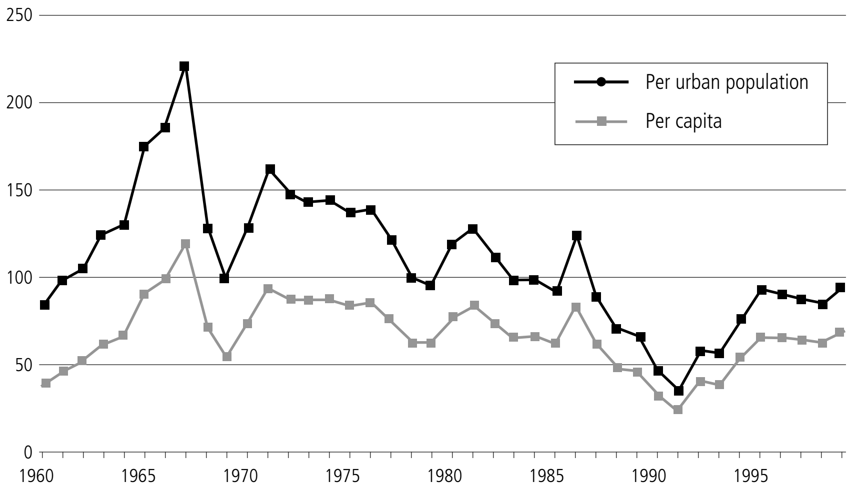
Description of the Growth Accounting Exercise

A standard growth accounting exercise was performed to identify periods in which factor accumulation had been low and periods in which TFP growth had been low. This analysis facilitated a search for alternative answers within the context of a neoclassical growth model.

Production Function

Consider economic production to be represented by a Cobb-Douglas production function. Output level is denoted by Y_t, the technological parameter by A_t, the stock of physical capital by K_t, the quality of human capital by H_t, employment by L_t, and the share of capital in total production by α (which is constant), assuming constant returns to scale. Then:

Figure 7.17. Education Expenditure Per Capita



$$Y_t = A_t K_t^{\alpha} \left(H_t L_t \right)^{1-\alpha}, \tag{7.3}$$

where $0 < \alpha < 1$. Taking logs and differentiating with respect to time yields:

$$g_y = g_A + \alpha g_K + (1-\alpha)(g_H + g_L), \tag{7.4}$$

where g_x is the growth rate of the variable x. In order to estimate TFP growth, the previous equation is expressed in the following form:

$$g_A = g_y - \alpha g_K - (1-\alpha)(g_H + g_L) . \tag{7.5}$$

Clearly we first need an estimate of the share of capital to obtain the desired result.

Estimating α

There are two alternative methods to estimate the share of capital. First, one can calculate α from the national income accounts, computing the ratio of capital income plus depreciation with respect to GDP. The problem with this method is that the data provided by INEI seem to be insufficiently reliable. According to INEI's national accounts, the capital share had a surprisingly stable value of 0.33 between 1950 and 1977. However, the capital share has shown steady growth since 1978, reaching a value of 0.55 in 1994, the last year for which this statistic was calculated. Given that the capital-labor ratio has not increased since 1978 and has actually decreased since 1983, one can assume that the upsurge in capital share is the consequence of a change in INEI's calculation methodology rather than a modification in how capital and labor are combined. An independent estimation carried out by IPE (2001) obtained a capital share of 0.64 for the 1991–99 sample.

A second method estimates the production function by considering it as a long-term relationship among GDP, physical capital, and labor. For this estimation one assumes one is at the steady state, and therefore TFP is constant. Without lack of generality, the value can be normalized to 1.

As all series were $I(1)$, the Johansen and Juselius (1990) cointegration method was used to find an estimate of α.[9] Table 7.2 reports that a single cointegration vector was encountered, with an estimate of $\alpha = 0.441$. However, since the results were not robust to sample changes, we decided to perform the growth accounting exercise with this estimation and with the typical value for $\alpha = 1/3$. Our estimated values for α lie below previous calculations as reported in Table 7.3.

Estimating TFP Growth

When all the variables involved in calculating TFP growth had been computed, we performed several growth accounting exercises. First we present baseline estimates that we correct for the quality of the labor force, and then we use a disaggregation of capital stock.

Table 7.4 shows the average growth rates of GDP, total capital stock (and its components), and the labor force for the five decades since 1950.

[9] An alternative method from the literature is to use ordinary least squares estimates of the production function. The problem with this method is its failure to take into account the potential endogeneity bias that will affect the estimate of α. Moreover an ordinary least squares estimate does not use the long-term relationship that might be present in the data as one would expect.

Table 7.2. Cointegration with One Type of Capital

Series: Log *Y*, Log *K*, Log *L*
Sample (adjusted): 1952–1999
Unrestricted cointegration rank test

Hypothesized no. of CE(s)	Eigenvalue	Trace statistic	Critical value 5 percent	Critical value 1 percent
None**	0.454990	46.12138	34.91	41.07
At most 1	0.220115	16.98769	19.96	24.60
At most 2	0.099946	5.054439	9.24	12.97
Hypothesized no. of CEs	**Eigenvalue**	**Max-eigen statistic**	**Critical value 5 percent**	**Critical value 1 percent**
None**	0.454990	29.13370	22.00	26.81
At most 1	0.220115	11.93325	15.67	20.20
At most 2	0.099946	5.054439	9.24	12.97

Normalized cointegrating coefficients (std. err. in parentheses)

Log *Y*	Log *K*	Log *L*	*C*
1.000000	–0.441153	–0.156686	–3.233907
	(0.16525)	(0.20894)	(0.33044)
Log likelihood	493.4480		

* Denotes rejection of the hypothesis at the 5% level of significance.
** Denotes rejection of the hypothesis at the 1% level of significance.

Table 7.3. Estimations of α in Previous Studies

Studies	α	Estimation method
Vega-Centeno (1989)	0.55	
Vega-Centeno (1997)	0.65	From Elías (1992)
Seminario and Beltrán (1998)	0.40	Johansen & Juselius, Stock & Watson
Calvo and Bonilla (1998)	0.76 and 0.71	Johansen & Juselius
Vallejos and Valdivia (1999)	0.69	
IPE (2001)	0.64	Johansen & Juselius

Remarkably the GDP growth rate declined until the 1990s, when a new burst of growth began but at a much slower pace than in the 1950s or 1960s.

Table 7.5 contains the results of TFP growth using the simplest case. Surprisingly, TFP declined during the 1970s and 1980s, and only recovered

Table 7.4 Average Growth of Output, Capital, and Labor
(in percent)

	GDP	Capital and equipment	Machinery	Construction	Labor
1951–60	5.74	6.42	6.23	6.47	2.04
1961–70	5.33	4.85	6.38	3.98	2.73
1971–80	3.89	5.73	6.61	5.00	3.33
1981–90	–0.68	2.39	0.32	3.65	3.09
1991–99	4.17	3.38	–1.17[a]	4.44[a]	2.90
1950–99	3.66	4.54	3.62	4.70	2.82
1960–99	3.15	4.08	2.98	4.27	3.01

[a] Average for 1991–95.

Table 7.5. Baseline Model Average TFP Growth
(in percent)

		Contribution of		
	GDP	Capital	Labor	TFP
1951–60	5.74	2.83	1.14	1.77
1961–70	5.33	2.14	1.53	1.66
1971–80	3.89	2.53	1.86	–0.50
1981–90	–0.68	1.06	1.73	–3.47
1991–99	4.17	1.49	1.62	1.06
1950–99	3.66	2.01	1.58	0.08
1960–99	3.15	1.80	1.68	–0.33

in the 1990s. Moreover, average TFP growth for the last 50 years has been almost zero, with a marked decline in the 1980s that was only partially recovered in the 1990s.

After correcting for the labor force using a human capital index, Table 7.6 shows that new TFP growth rates are smaller than before. The main difference is that when we account for human capital accumulation, the contribution of the labor factor is greater. The net contribution of education is 0.34 percent of higher annual GDP growth.

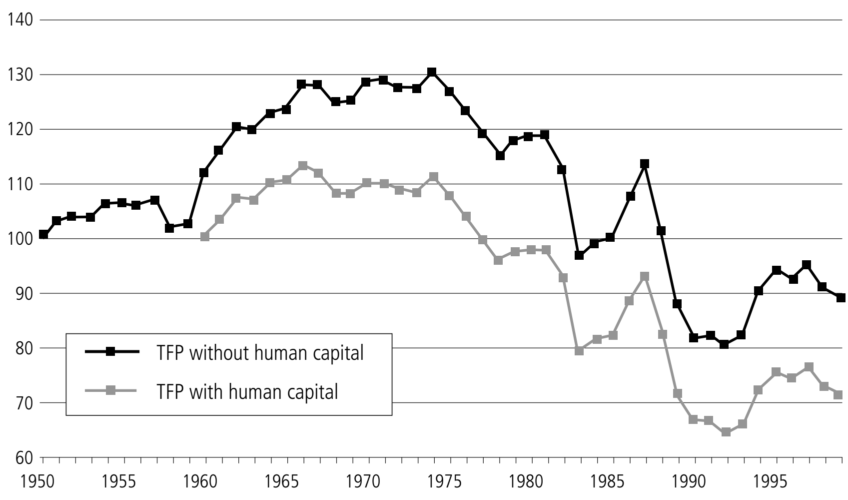
The most striking feature in Figure 7.18 is the downward trend of TFP since the late 1960s. It prompts the seemingly simple question of explaining why TFP falls. Yet the question is almost shocking, since custom-

Table 7.6. Average TFP Growth, Corrected for Human Capital
(in percent)

		Contribution of		
	GDP	Capital	Human capital	TFP
1961–70	5.33	2.14	2.07	1.11
1971–80	3.89	2.53	2.30	–0.94
1981–90	–0.68	1.06	1.92	–3.66
1991–99	4.17	1.49	1.77	0.91
1960–99	3.15	1.80	2.02	–0.66

arily TFP is thought of as the extra gain in output that can be squeezed from inputs depending on how they are combined. So, for example, improved technology/skills will magnify output with the same inputs. Latin America's technical progress comes from importing technology or training its labor force with new skills. The number of patents is almost negligible. A plausible explanation for TFP declines might be a vast mismatch of job skills and requirements. The agrarian reform of the late 1960s did provoke a large decline in productivity and profitability in Peru at a time in which half of the PEA worked in the agricultural sector, reinforcing

Figure 7.18. Calculating TFP Using Total Physical Capital (1950–99)



this hypothesis. However, the fall is too steep and calls for an additional explanation.

Given that these numbers were very suspicious, alternative calculations were tried to test the robustness of the initial results. Alternative estimations are reported in Table 7.7. The first two columns are our baseline estimations with and without including the effect of human capital (*H*) in the labor factor. A first set of alternative calculations disaggregates two types of physical capital: machinery and equipment, and construction. Another set uses a more typical value for the share of physical capital (α = 0.33) for all the possibilities. Basically these calculations confirm our initial results.

To put these results in perspective, Table 7.8 shows previous estimates of TFP for Peru. As one can see, our estimates are not far from earlier calculations.

One crucial similarity spans these estimations: Peru has endured long periods in which TFP growth has been negative. Basically since the early 1970s TFP has been declining steadily, with two brief periods of TFP growth. Of course it is hard to imagine how an economy could manage to destroy knowledge or reverse technical progress.

There are three competing hypotheses behind these results: subutilization, misallocation or bad reporting of inputs. The subutilization

Table 7.7. Alternative TFP Calculations for Average Growth Rates *(in percent)*

	α = 0.44				α = 0.33			
	One type of *K*		Two types of *K*		One type of *K*		Two types of *K*	
	No *H*	*H*	No *H*	*H*	No *H*	*H*	No *H*	*H*
1951–60	1.77	n.d.	1.78	n.d.	2.24	n.d.	2.25	n.d.
1961–70	1.66	1.11	1.67	1.12	1.89	1.24	1.90	1.24
1971–80	–0.50	–0.94	–0.43	–0.87	–0.24	–0.77	–0.19	–0.72
1981–90	–3.47	–3.66	–3.50	–3.70	–3.54	–3.78	–3.56	–3.80
1991–99	1.06	0.91	2.98[a]	2.62[a]	1.11	0.93	2.95[a]	2.52[a]
1950–99	0.08	n.a.	0.47	n.a.	0.27	n.a.	0.64	n.a.
1960–99	–0.33	–0.66	0.15	–0.24	–0.22	–0.62	0.24	–0.22

[a] Average for 1991–95.

Table 7.8. Previous TFP Estimations for Average Growth Rates
(in percent)

	Vega-Centeno (1989)	Fernández-Baca and Seinfeld (1995)	Vega-Centeno (1997)	Seminario and Beltrán (1998)	Calvo and Bonilla (1998)	Vallejos and Valdivia (1999)	IPE (2001)
1950–59	1.5	1.6	1.1	1.0		2.7	1.5[g]
1960–69	2.0	1.3	1.3	2.5		1.7	1.4[h]
1970–75	2.1	1.4	–0.6	1.8		–0.6[d]	–0.8[i]
1976–80	0.0	–1.7	–1.0	–1.3			
1981–85	–1.3	–3.9	–1.4	–3.6		–4.0[e]	–3.9[j]
1986–90	1.9[a]	–7.3	–3.4	–3.7			
1991–95			–0.4[b]	3.4	1.8[c]	1.8[f]	1.0[k]
1996–2000							
1950–2000							–0.1

[a]1986–88; [b]1991–96; [c]1993–96; [d]1970–80; [e]1980–90; [f]1991–98; [g]1951–60; [h]1961–70; [i]1971– 80; [j]1981–90; [k]1991–2000

hypothesis could only account for cyclical movements of TFP but not the clear negative trend.[10] Another possible explanation is informality. One can argue that some factor accumulation within this sector has not been properly measured and therefore distorts the TFP calculations. One major problem with this is the lack of series to support (or reject) this claim. However, one can suppose that, due to the crisis, labor migrates from the formal to the informal sector. Hence, if we include the informal sector in our computation of the growth rate of labor, the puzzle will not vanish as inputs will be increasing much quickly. The other possible explanation is a severe loss of productivity due to misallocation of inputs. Due to highly distorted incentives or restrictions to mobilize factors across sectors, a given level of inputs generates less output, and therefore TFP is lower. Latin America is a region in which technical progress comes from importing technology or training the labor force with new skills. The number of patents is almost insignificant. Maybe a plausible explanation of the declines in TFP is an overwhelming mismatch of job skills and job characteristics. One of the

[10] The relevant data to compute a proper TFP measure without the cyclical component due to a variable capacity utilization rate are not available.

problems faced by an economy characterized by high levels of underemployment is that a large proportion of people work in activities for which they do not have training. These mismatches will generate the result that even highly educated workers might have low levels of productivity.

Another reason that may reinforce the first factor is that the agrarian reform of the late 1960s provoked a large decline in productivity and profitability in a country in which half of the PEA worked in the agricultural sector by that time. However, the fall is too steep and calls for an additional explanation.

There is still another way to interpret a decreasing TFP, which we cover in the next section. The idea is simple. If the valuation method of the inputs is faulty, the measure of TFP will be faulty as well.

Assessing TFP via Pritchett

Pritchett (1997, 1999) argues that the typical way of computing a measure of public capital stock may not capture its true value. Empirical studies on economic growth calculate the capital stock as the cumulative depreciated present value of investment flows. However, it is hard to believe that in the great majority of developing countries the government's investment cost coincides with the true value of public capital. This point is crucial if we are convinced that slow growth is actually caused by government investment failing to create productive capital rather than the result of too little government investment.

Thus even if public capital represents a sizeable positive externality to private capital, it may be very difficult to create such capital in the public sector. If so, fostering concessions of public infrastructure might be preferable to expecting that government will do the job.

Pritchett offers a method for approximating the size of the distortion between the cost of investment and the value of capital. The method consists of three steps. First, calculate TFP growth using the traditional growth accounting exercise. Second, assume that "true" TFP growth for the country could be anything between zero and one. Zero is an obvious lower bound since negative TFP growth is hard to justify, and 1 percent is the OECD country average. Realizing that this assumption may produce inconsistencies with the observed factor accumulation, we report only the results for assuming zero TFP growth, since it is much closer to the observed rate in Latin American countries. Third, scale back the rate of factor accumulation to be consistent with the observed rate of growth or output per worker and the assumed TFP. This will yield an estimate of the implied factor accumulation.

The unlikelihood of negative TFP growth rates in an economy is built into this exercise. Rather than trying to imagine how an economy could become less technologically adept, forgetting knowledge accumulated through the years, Pritchett suggests a different explanation indicating that economies are valuing investment without taking into account its quality (productivity). One immediately thinks of the herds of "white elephants" that most Latin American economies bred in the 1960s and 1970s, and of roads that wash away in the first season of heavy rain. The theory that lower TFP growth comes from overvaluing investment, which has actually resulted in a lower capital accumulation, is a much more compelling story.

Results reported in Table 7.9 assume human capital makes no contribution in the calculation of TFP growth, while results in Table 7.10 include the factor.

A small ratio of implied to observed factor accumulation should be understood as evidence that the "true" story of the economy was poor investment decisions rather than deterioration in technological progress. The evidence for Peru shows that the 1980s was a period when most public investment was poorly allocated. The late 1970s and the last five years of the Fujimori government were only slightly better.

As in our previous calculations, human capital improvement is not a major factor driving TFP growth. Little difference separates the estimates whether or not this factor is taken into account.

In any case, the difference is startling when comparing these results with our previous estimates using the Solow model (Figure 7.19). By the late 1960s, the divergence began to widen steadily. This coincides with the period of major public investment projects such as the gas pipeline. What

Table 7.9. Actual and Implied Factor Accumulations, without Human Capital

	Observed factor accumulation	Observed TFP (Solow)	TFP (Pritchett)[a]	Implied factor accumulation[a]	Implied/ observed (%)[a]
1951–55	6.98	1.98	1.98	6.98	100.00
1956–60	5.87	1.56	2.52	3.69	62.85
1961–65	5.41	2.33	2.35	5.36	99.06
1966–70	4.30	1.00	1.51	3.14	73.03
1971–75	6.86	0.17	0.80	5.42	78.98
1976–80	4.59	–1.16	0.64	0.50	10.96
1981–85	3.24	–3.13	0.75	–5.56	0.00
1986–90	1.55	–3.80	2.56	–12.87	0.00
1991–95	2.56	2.93	3.42	1.44	56.41
1996–99	4.41	–1.28	0.67	0.01	0.15
1950–99	4.58	0.09	1.74	0.83	48.14
1961–99	4.11	–0.35	1.61	–0.33	39.82

[a]Assumes that TFP = 0.

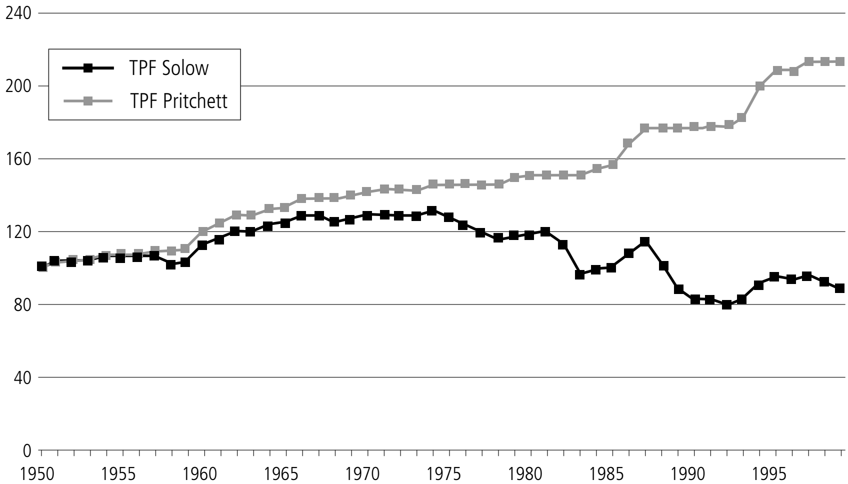
separates these two TFP estimates is our measure of the inadequacy of public investment decisions during the past 40 years. It is hard to imagine the entire decline being attributable to adverse shocks, bad policies, or something similar.

Table 7.10. Actual and Implied Factor Accumulations, with Human Capital

	Observed factor accumulation	Observed TFP (Solow)	TFP (Pritchett)[a]	Implied factor accumulation[a]	Implied/ observed (%)[a]
1961–65	5.41	2.36	2.38	5.36	99.06
1966–70	4.30	–0.13	0.88	2.00	46.59
1971–75	6.86	0.01	0.70	5.29	77.07
1976–80	4.59	–1.89	0.38	–0.56	0.00
1981–85	3.24	–3.32	0.65	–5.74	0.00
1986–90	1.55	–4.01	2.47	–13.14	0.00
1991–95	2.56	2.57	3.19	1.15	45.02
1996–99	4.41	–1.17	0.70	0.19	4.21
1961–99	4.11	–0.68	1.44	–0.70	38.25

[a]Assumes that TFP = 0.

Figure 7.19. Comparing Solow versus Pritchett TFP Estimates



A final exercise was performed to see if public investment was the major culprit. We assumed such investment would depreciate fully in the first year to test the notion that public investment's contribution to capital formation was slim. The results basically mirror those of our previous exercise.[11] The ratio of implied to observed factor accumulation was about 50 percent for the 1950–99 period and 43 percent for the 1960–99 period, compared to the 48 percent and 40 percent reported in Table 7.9, respectively. This should not be surprising since the most likely candidate to overvalue investment is the public sector. Is it possible to explain the decline in TFP by adverse external shocks, bad policies, or other causes along those lines? In the next section we attempt to answer this question.

Explaining TFP Growth

Even though the previous exercises permitted us to obtain different measures of TFP growth, they do not tell us what the main driving forces are. However, competing hypotheses can be tested to see which is supported in

[11] Detailed tables are not included, since the estimates were so similar, but are available upon request.

the data. The methodology of Jadresic and Zahler (2000) was adapted to test the Peruvian data. Those authors proposed three different hypotheses for explaining TFP growth: good policies, just plain good luck, or a good institutional stance. We also examined a fourth hypothesis in which government policies are divided into macroeconomic and social policies.

The econometric exercise consists of estimating an equation for TFP growth based on a list of variables that may encompass the four possible explanations. Thus,

$$TFP_t = \beta_0 + \beta_1 MF_t + \beta_2 EF_t + \beta_3 IF_t + \beta_4 SF_t + \varepsilon_t, \quad (7.6)$$

where *MF*, *EF*, *IF*, and *SF* are macro, external, institutional, and social factors, respectively. Macroeconomic factors representing variables that capture various macro policy decisions include the inflation rate, inflation variability, the degree of openness, the real exchange rate, and the external debt burden. The ratio of public external debt was used to construct the last variable. The real exchange rate might be used as a proxy for the relative price of imported capital to domestic consumption goods.

An additional variable that we used, which required additional work to enlarge the available sample for the series, is a structural reform index computed by Morley, Machado, and Pettinato (1999), extending previous work by Lora and Barrera (1997). The available sample extends from 1970 to 1995. We planned to extend this series at least 10 more years; one cannot simply assume no changes prior to 1970, since a major tax reform, a land reform, and other crucial events occurred during the 1960s.

Terms of trade and the real interest rate of the U.S. economy were used to capture external positive or negative shocks. Two definitions of terms of trade were used that come from work at the Peruvian Central Bank by Tovar and Chuy (2000) in which an alternative index is computed instead of the standard Paasche index. We also controlled for foreign GDP growth, using Latin American, U.S., and world GDP growth as proxy variables. We linked external factors as “good or bad luck” shocks.

Another “good or bad luck” variable is the recurrent El Niño phenomenon. Ocean warming in the far-off Pacific provokes large swings in

Peru's weather, causing heavy coastal rains that damage infrastructure and crops, disrupting fishing, and causing severe droughts in the southern part of the country. Instead of using a dummy variable for the years when the phenomenon was intense, we used the Southern Oscillation Index computed by the U.S. National Oceanic and Atmospheric Administration (NOAA). However, we compute the standard deviation of this index as our proxy since El Niño's intensity depends on the relative variability of temperatures.

The institutional factors are represented by a composite index called Polity, which is derived from the Polity IV project directed by M. Marshall and K. Jaggers,[12] who update the Polity III database on political regime characteristics for several countries compiled by Jaggers and Gurr (1995). The Polity index combines two indexes, AUTOC and DEMOC, measuring the degree of institutionalized autocracy and democracy, respectively. Both indexes are computed taking into account different aspects of five variables: (1) the competitiveness of executive recruitment, (2) the openness of executive recruitment, (3) constraints on the chief executive, (4) the regulation of participation, and (5) the competitiveness of participation. One could expect that a better institutional framework of an economy may have a positive impact on investment and carry out a higher TFP.

To account for social factors, we included government expenditure on education per capita, and could have included school enrollment (especially that in tertiary education) or life expectancy at birth.

Figure 7.20 shows the time series of the most representative variables used in this econometric exercise.

To explain the factors explaining the dynamic behavior of TFP growth, we naturally began by testing for cointegration among the variables, seeking to estimate an error correction model that would capture the dynamics. In order to do so, we checked for unit roots in the variables through Dickey-Fuller tests. Table 7.11 reports the findings, with all variables stationary in first differences; the only exception was the El Niño indicator, so we exclude it from our estimations.

[12] Available at http://www.cidcm.umd.edu/inscr/polity/.

Figure 7.20. Selected Variables

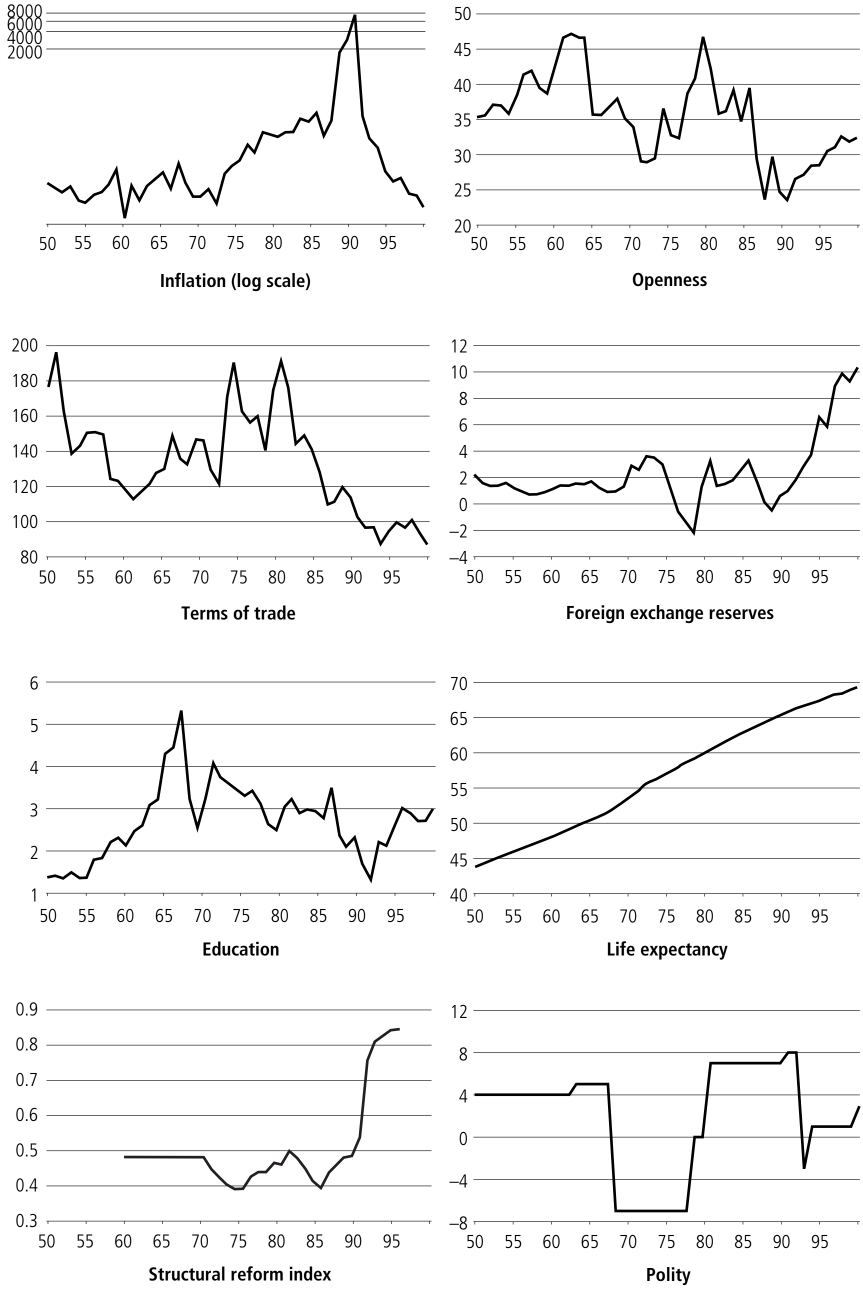
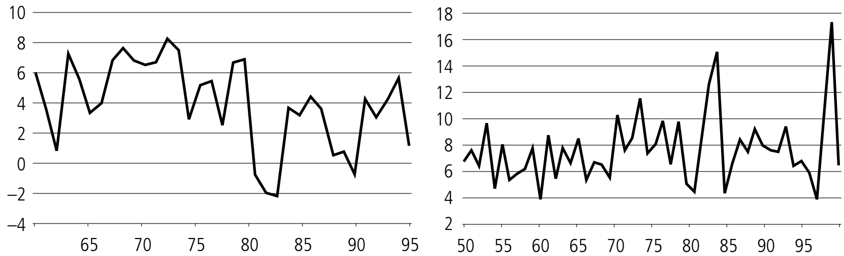


Figure 7.20. Selected Variables *(continued)*



However, the sample is very limited, so that even if a cointegration relationship is found, the error correction model associated with that estimation would imply too many parameters for the narrowness of the sample. Therefore we decided to use the stationary variables and estimate a regression using ordinary least squares that mimics an error correction model without taking the lags into account.

Table 7.11 reports the regressions for TFP growth (with and without adjusting for the quality of labor) explained by the (log) inflation rate, the terms of trade, the degree of openness (exports plus imports as a per-

Table 7.11. Unit Root Tests for Selected Variables

	Test for unit root in levels		Test for unit root in first differences	
	1 lag	2 lags	1 lag	2 lags
TFP	–1.35	–1.00	–4.81*	–4.47*
Inflation	–1.72	–1.98	–4.42*	–4.15*
Openness	–2.07	–1.80	–5.69*	–4.21*
Terms of trade	–2.52	–1.17	–7.45*	–4.84*
Real exchange rate	–0.91	–1.52	–2.64*	–2.72*
Foreign interest rate	–1.42	–1.27	–4.30*	–3.20*
Public debt/GDP	–2.23	–2.05	–4.52*	–4.10*
Latin American GDP	–3.16	–2.20	–6.70*	–4.70*
El Niño	–5.23*	–4.28*	–7.90*	–6.43*

Note: All variables are stationary in first differences.
*Rejection of unit root hypothesis significant at 1 percent.

centage of GDP), a measure of debt burden, our Polity index and the structural reform index, and the Latin American GDP growth rate.

We tried four alternative specifications. In the first equation we included all macro and good/bad luck factors. The results indicated that high inflation rates, high levels of public indebtness, and an undervalued real exchange rate are the wrong policies to improve TFP. This seems reasonable as Peru went from low levels of inflation to a hyperinflation process (1988–90) that is just the mirror image of fiscal and monetary mismanagement. We also tried with the inflation variability and the results were similar. This variable could also capture the level of policy uncertainty that could be a fundamental explanation as in Manuelli (2001).[13]

The effect of external shocks is quite important as both the foreign interest rate and the terms of trade were statistically significant; the Latin American growth rate entered with the right sign but was not statistically significant. We tried with the world growth rate but the results did not change.

One puzzling result is that openness had the wrong sign and was not statistically significant. The reason is a simple problem of multicollinearity with terms of trade and real exchange rate. To prove this we estimated our second equation without those variables and the results were as expected. A larger degree of openness improved TFP, and the rest of the results remained the same.

In our third equation we tested the importance of the institutional factor and the structural reform indicator. However, the results were quite disappointing as the coefficient for the structural reform index appeared with the wrong sign and was not statistically significant, while the Polity index had the right sign but was not statistically significant. We argue that this variable tries to capture the positive impact of an institutional setup in which the executive decisions consider a broad group of individuals instead of a few vested interest groups. Given that TFP has been declining

[13] We tried another usual indicator of bad policies, the black-market premium, but as this variable is too highly correlated with inflation (0.40), it did not help to identify other periods of bad policies.

Table 7.12. Explaining TFP Growth

	TFP (not adjusting for labor quality)		TFP (adjusting for labor quality)	
C	157.80***	113.47***	161.35***	130.59***
Log (Inflation)	–1.82*	2.18*	–0.26*	–3.51***
Openness	–0.49	1.08***		
Terms of trade	0.17**		0.09*	0.20***
Real exchange rate	–0.35***		–0.24**	–0.32***
Foreign interest rate	–1.03*	–1.75**	–1.16*	–1.81***
Public debt/GDP	–0.37***	–0.8***	–0.45***	
Latin American growth	0.05			
Polity			0.21	
Structural reform			–28.50	
Sample	1970–99	1970–99	1970–99	1962–99
Included observations	30	30	30	38
R^2	0.94	0.77	0.94	0.87
Durbin-Watson	1.29	0.82	1.20	0.96

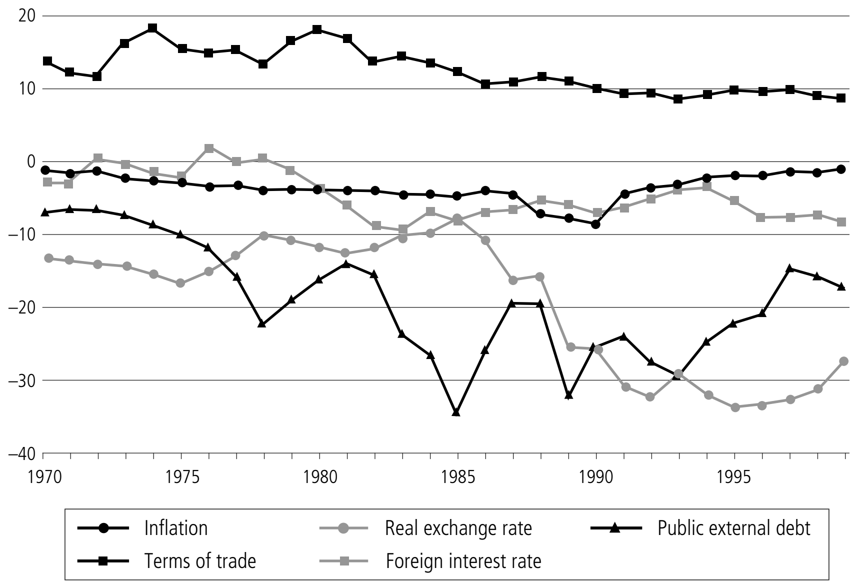
* Coefficients are statistically significant at 10%.
** Coefficients are statistically significant at 5%.
*** Coefficients are statistically significant at 1%.

most of the time, the positive relationship with this index is an indicator of the weakness of our institutional framework.

We performed a simple robustness check that consisted of eliminating the external debt variable in order to cover an additional decade. The results of our fourth equation showed that the coefficients were about the same and the cointegration relationship was still present.

In order to compare which factors are more important for TFP, we present the contribution of each variable to TFP (see Figure 7.21). The results indicate that terms of trade, the real exchange rate and the ratio of public external debt to GDP are the main contributing factors, whereas inflation and the real foreign interest rate come in second place. In other words, even though external factors might play a crucial role in TFP, there is plenty of room for domestic policy to improve TFP conditions. However, these results should be taken with a grain of salt as some explanatory variables are correlated and therefore their individual impact could be masked in another variable.

Figure 7.21. Effect on TFP



Conclusion

The growth accounting exercise shows the deep changes that Peru's TFP has undergone during the past four decades. After having positive and significant technological progress during the 1950s and 1960s, with an annual TFP growth rate slightly below 2 percent, the Peruvian economy went through two decades of marked decline, as shown by negative technological progress that reached an annual TFP contraction rate of –3.8 percent during the 1980s.

What happened to the Peruvian economy? Echoing Zavalita's fundamental question with which this chapter opened: How did Peru screw up? Answering that question began with Pritchett's method, which focuses on the quality of public investments. Following Pritchett's procedure our calculations showed that investment decisions were quite good until 1965, in the sense that the observed factor accumulation coincided with the implied values. The second half of the 1960s marked a new phase with the beginning of a gradual decline in the ratio of observed to implied factor accumulation. The situation worsened during the 1980s when the ratio fell to zero, showing that new investments were worthless.

A second approach to answering the question is provided by the traditional econometric exercise of using a linear regression equation to try to find out which variables explain TFP. This exercise was carried out with a selected set of variables grouped in four categories: macro factors, good/bad luck, institutional factors, and social factors.

The estimated coefficient corresponding to macro factors in Table 7.12 provides significant evidence for a hypothesis presented early in the chapter, that is, the relationship between the gradual deterioration of macro factors, especially those related with fiscal and monetary mismanagement during the 1970s and the 1980s, and the decline in TFP growth.

Although the institutional variable and the structural reform index turned out to be not significant, this does not necessarily mean that those factors are not important. Moreover, the fact that Peru is an economy in which the external factors are central should provide an additional incentive to maintain a preventive approach to external crises. Shocks of external origin might arise from a deterioration in the terms of trade, an increase in the cost of external financing, or a global slowdown.

It is also important to note that changes in macroeconomic management as well as institutional factors unquestionably affect the quality of investments, as Pritchett's method suggests. Further study should focus on the relationship between the two methods employed in this chapter to explain changes in TFP growth.

Finally, the last 50 years in Peru can be seen as a constant struggle between the government and antagonistic groups seeking sector-specific incentives. In this struggle, the nation shifted from one side to the other of the economic policy pendulum. The main characteristic of the economic policy is by far its unpredictability. Rules are short-term rules. Laws are short-term laws. Even the constitution changes constantly.

The unpredictability of Peru's economic policies and the political regimes brings out myopic and opportunistic behavior from the decision maker in place. Although the "to do" list is quite long, the focus should be on the design of incentives and mechanisms in order to avoid a large misallocation of inputs and to narrow the range of possible economic policy decisions.

Appendix 7.A

Data Definitions

1. Macro Time Series[14]

Domestic Product

- *GDP:* Gross domestic product in current international dollars (converted to international dollars using purchasing power parity rates) and gross domestic product at market prices (in current dollars and in current local currency).
- *GDP growth:* Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 1995 U.S. dollars.
- *Real GDP per capita* dollars in constant prices (international prices, base year 1985): The measure of GDP, excluding the effect of inflation, relative to the population.
- *GDP per capita growth*: Annual percentage growth rate of real GDP per capita.

Population

- *Population:* Residents of a country, regardless of legal status or citizenship.
- *Population growth:* Annual percentage growth rate of the population.
- *Urban population:* The midyear population of areas defined as urban in each country. It is measured here as a percentage of the total population.

[14] Global Development Finance and World Development Indicators, World Bank online databases.

Trade

- *Terms-of-trade adjustment:* The terms-of-trade effect equals capacity to import with the exports of goods and services in constant prices. Data are in constant local currency.
- *Exports of goods and services:* The value of all goods and other market services provided to the rest of the world. Data are in current U.S. dollars (BoP) and in percentage of GDP.
- *Imports of goods and services:* The value of all goods and other market services bought from the rest of the world. Data are in current U.S. dollars (BoP) and in percentage of GDP.

Exchange Rate

- *Official exchange rate:* The actual, principal exchange rate determined by market forces in the exchange market. Data are expressed in local currency units relative to U.S. dollars. It is an annual average.
- *Real effective exchange rate index:* CPI(local)/(CPI(U.S.)*official exchange rate).
- *Black-market premium:* Official exchange rate to parallel exchange rate ratio.

Prices

- *Consumer price index (1995 = 100):* Reflects changes in the cost to the average consumer of acquiring a fixed basket of goods and services.
- *Inflation:* The annual percentage change in the consumer price index.

Interest rate

- *Domestic and U.S. real interest rate:* The deposit interest rate less the rate of inflation measured by the GDP deflator.[15]

[15] Global Development Finance and World Development Indicators; Easterly and Schmidt-Hebbel (1994, statistical appendix).

- *M2 as a percentage of GDP:* Money and quasi-money relative to GDP.

Government Finance

- *Overall budget surplus:* Current and capital revenue and official grants received, less total expenditure and lending minus repayments. Data are shown including and excluding grants received by the central government.[16]
- *Total external debt:* Debt owed to nonresidents. It is the sum of public, publicly guaranteed, and private non-guaranteed long-term debt, use of IMF credit, and short-term debt. Data are in current U.S. dollars and in percentage of GDP.

Investment

- *Gross domestic investment:* Outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Data are in percentage of GDP.
- *Public investment:* Investment of public origin.[17]
- *Private investment:* Investment of private origin.[18]

2. Micro Time Series[19]

- *Capital stock (using disaggregated investment data):* Accumulated investment minus assets depreciation. It considers a different rate of depreciation for each kind of fixed asset.
- *Capital per worker:* Accumulated investment minus assets depreciation, related to the labor force. It was computed using the Heston and Summers methodology.

[16] Global Development Finance and World Development Indicators; Easterly and Schmidt-Hebbel (1994).
[17] Easterly and Schmidt-Hebbel (1994); Pfeffermann, Kisunko, and Sumlinski (n.d.); Bruno and Easterly (1998).
[18] Global Development Finance and World Development Indicators; Pfeffermann, Kisunko, and Sumlinski (n.d.).
[19] Easterly and Levine (1999).

- *Capital per worker, using disaggregated investment data:* This measure of capital per worker takes into account that different kinds of capital exhibit different rates of depreciation.
- *Capital per worker, using aggregated investment data:* This measure of capital per worker considers the same rate of depreciation for every kind of fixed asset.

3. Social Indicators[20]

- *School enrollment (primary, secondary, and tertiary):* Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Primary education provides basic skills and an elementary understanding of various subjects. Secondary education completes the provision of basic education by offering more subject- or skill-oriented instruction. Tertiary education provides an advanced research qualification.
- *Life expectancy at birth*: This indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of birth were to stay the same throughout his/her life.

4. Political Factors[21]

- *Type of regime:* (1) civilian, (2) military-civilian, (3) military, (4) other.
- *Size of military/population:* All active-duty members of a nation's armed forces (army, navy, and air corps). Semi- or paramilitary forces are excluded.
- *Major cabinet changes:* The number of times in a year that a new prime minister is appointed and/or 50 percent of the cabinet seats are occupied by new ministers.

[20] Global Development Finance and World Development Indicators.
[21] Arthur S. Banks Cross-National Time Series Data Archive.

- *Major government crises:* The number of situations in which the present regime is threatened to be deposed, excluding revolts intended to overthrow.
- *Riots:* The number of violent demonstrations or clashes of more than 100 citizens involving the use of physical force.
- *Revolutions:* The number of illegal or forced changes in the top governmental elite and attempts at such a change.
- *Coups d'état*: The number of extra-constitutional or forced changes in the top government. Only successful coups are counted.
- *Guerrilla warfare:* The number of armed activities carried out by irregular forces with the intent of overthrowing the present regime.

5. The Rule of Law

Executive Recruitment[22]

- *Regulation of chief executive recruitment:* The extent to which a polity has institutionalized procedures for transferring executive power—(1) unregulated, (2) designational, or (3) regulated.
- *Competitiveness of executive recruitment:* The extent that prevailing modes of advancement give subordinates equal opportunities to become superordinates. Three categories are used to measure this concept: (1) selection, (2) dual executives/transitional, and (3) competitive elections.
- *Openness of executive recruitment:* The extent to which the politically active population has an opportunity to attain office through a regularized process. Four categories are used: (1) closed/hereditary succession; (2) dual executive-designation, i.e., hereditary succession plus executive selection of an effective chief minister; (3) dual executive-election, i.e., hereditary succession plus electoral selection of an effective chief minister; and (4) open.

[22] Jaggers and Gurr (1995).

Independence of Executive Authority[23]

- *Major constitutional changes:* The number of basic alterations in a state's constitutional structure, the extreme case being the adoption of a new constitution. Constitutional amendments not having a significant impact on the political system are not counted.[24]
- *Monocratism:* The extent to which the chief executive must take into account the preferences of others when making decisions. Distinction between patterns in which one-man rule prevails (monocratic) and those in which some kind of assent is required (concurrent). Five categories are used: (1) pure individual executive not dependent for his position or authority on a cabinet or junta; (2) intermediate category; (3) qualified individual executive, i.e., the executive is formally a cabinet but one member holds more authority than the others; (4) intermediate category; and (5) collective executive, i.e., the executive is formally a committee or junta clearly dominated by no individual.
- *Executive constraints (decision rules):* The extent of institutionalized constraints on the decision-making powers of chief executives, whether individuals or collectivities. Any accountability groups may impose such limitations. Seven categories are used: (1) unlimited authority, (2) intermediate category, (3) slight to moderate limitations on executive authority, (4) intermediate category, (5) substantial limitations on executive authority, (6) intermediate category, and (7) executive parity or subordination.

Extent of Political Competition and Opposition

- *Party fractionalization index formula:* The extent to which the political system enables nonelites to influence political elites in regular ways, or

$$F = 1 - \sum_{i-1}^{m} \left(t_1 * t_1 \right), \qquad (7.A.1)$$

[23] Jaggers and Gurr (1995).
[24] Arthur S. Banks Cross-National Time Series Data Archive.

where t equals the proportion of members associated with the ith party in the lower house of the legislature.[25]

- *Regulation of participation:* Participation is regulated to the extent that there are binding rules on when, whether, and how political preferences are expressed. A five-category scale is used to code this dimension: (1) unregulated participation, i.e., there are no enduring political organizations and no systematic controls on political activity; (2) factional or transitional, i.e., there are relatively stable political groups, which compete for political influence; (3) factional/restricted, i.e., when one group secures power it restricts its opponents' political activities; (4) restricted, i.e., some organized political participation is permitted without intense factionalism; and (5) regulated, i.e., relatively enduring political groups regularly compete for political influence with little use of coercion.[26]
- *Competitiveness of participation:* The extent to which alternative preferences for policy and leadership are taken into account in the political arena. There are five categories of gradation: (1) suppressed competition, i.e., there is no significant opposition activity outside the ranks of the ruling party; (2) restricted/transitional, i.e., some political competition occurs outside government, but the regime systematically limits its form in ways that exclude substantial groups from participation; (3) factional competition, i.e., polities with factional or factional/restricted patterns of competition; (4) transitional competition, i.e., transitional elements from restricted or factional patterns to fully competitive patterns; and (5) competitive competition, in which stable and enduring political groups regularly compete for political influence. Very small parties or political groups may be restricted in the competitive pattern.[27]

[25] Arthur S. Banks Cross-National Time Series Data Archive.
[26] Jaggers and Gurr (1995).
[27] Jaggers and Gurr (1995).

Appendix 7.B

Estimation of Economic Growth Stages

Statistical evidence could have been used to support the subperiods chosen in this study; however, we deliberately chose not to identify the periods by statistical means. We picked those subperiods that could better reflect the major changes that occurred in the last 100 years in the economic history of Peru. The post–World War II period was interrupted in 1968 by a military coup. The 1988–90 hyperinflation was another major factor affecting the trend.

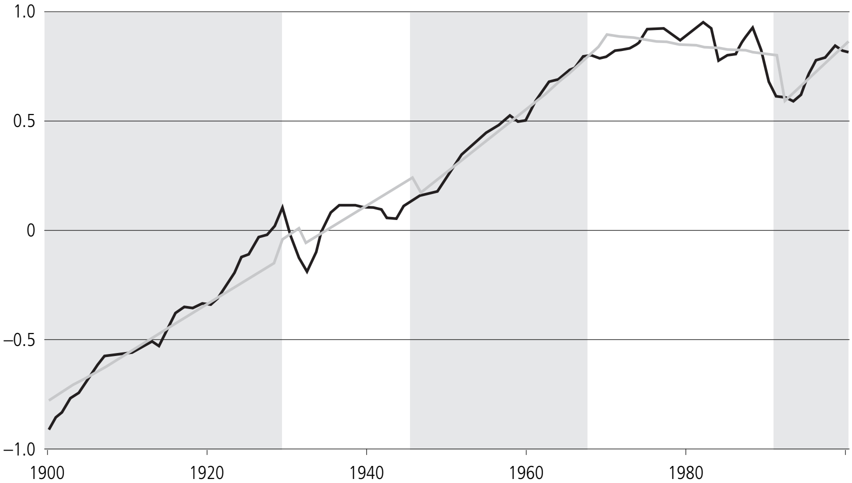
Here we show the econometric results of a linear specification taking into account these subperiods and an intercept change dummy for the Great Depression.

Dependent Variable: LGDP_PC
Method: Least squares
Sample: 1900–1999

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	–0.780293	0.020897	–37.34060	0.0000
DUM1945*@TREND	0.007516	0.002404	3.126194	0.0024
DUM1968*@TREND	–0.034814	0.003314	–10.50486	0.0000
DUM1990*@TREND	0.038030	0.009608	3.958209	0.0001
@TREND	0.022814	0.000809	28.20244	0.0000
DUM1945	–0.442695	0.131587	–3.364277	0.0011
DUM1968	2.431597	0.232674	10.45068	0.0000
DUM1990	–3.659017	0.904465	–4.045503	0.0001
DUM1930	0.080874	0.043495	1.859416	0.0662

R-squared	0.983979	Mean dependent var.	0.249668
Adjusted *R*-squared	0.982570	S.D. dependent var.	0.545527
S.E. of regression	0.072021	Akaike info criterion	–2.338019
Sum squared resid.	0.472024	Schwarz criterion	–2.103554
Log likelihood	125.9010	*F*-statistic	698.6209
Durbin-Watson stat.	0.543624	Prob(*F*-statistic)	0.000000

GDP Per Capita and Piece-Wise Linear Trend



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CHAPTER 8

Growth in Uruguay: Factor Accumulation or Productivity Gains?

Julio de Brun[1]

During the last five decades the Uruguayan economy faced volatile macroeconomic conditions. Economic policies swung from highly controlled capital flows, exchange rates, and interest rates to the introduction of significant financial liberalization. Periods of high inflation alternated with recurrent efforts to stabilize price movements. The public sector oscillated between intervention (including price controls) and deregulation, and between imposing strong barriers to imports and unilateral reductions of trade barriers, including creation of the Mercosur common market with neighboring countries.

Uruguay's economy went seriously off-course during this period. From being one of the most developed nations in the world at midcentury in terms of per capita income and other social indicators, Uruguay approached the millennium as a member of a less-select club, the group of middle-income countries struggling to get by.

According to data from the Penn World Table, in 1955 Uruguay's annual gross domestic product (GDP) per capita was US$4,285 (in 1985 international prices). This was close to the figure for France (US$4,770 per capita), higher than that for Austria and Italy, and 44 percent of U.S. per capita GDP. In 1998, according to the same source, Uruguay's GDP per capita had grown to US$6,058 but had fallen comparatively to 29 percent of the U.S. benchmark and to about half the level of France, Austria, and

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Italy. Uruguay's rate of growth between 1955 and 1998 was one of the lowest among the 60 countries for which data are available.

Most of this poor growth performance can be attributed to Uruguay's economic stagnation in 1955–73, when average per capita GDP decreased at a cumulative rate of 0.2 percent annually. During this period government policy was highly interventionist, especially in external trade but also toward the financial sector, as well as influencing key aspects of the domestic economy. The regime of controls ranged from setting wages and exchange rates to limitations on free entry in certain markets.

This environment changed substantially during the next decade. And for the past quarter century, successive governments have pursued policies that promoted the development of a market-oriented economy. At first glance, those efforts were successful: GDP per capita growth averaged 1.7 percent in 1973–2000, significantly better than the performance of the previous 18 years. Yet the rate is still much lower than those of other developing countries that also introduced market-oriented reforms during the last two decades.

This chapter will show that the upturn in economic growth since liberalization is due to improved resource allocation that, in turn, promoted an increase in human capital accumulation. No significant changes are observed in the pattern of physical capital accumulation or the evolution of total factor productivity (TFP).

The analysis begins with an overview of recent economic policy in Uruguay, summarizing the characteristics of each period. A growth accounting exercise is then conducted to begin weighing which factors are crucial to understanding the country's pattern of growth. This exercise will show, as previously stated, that TFP played a minimal role. This evidence is complemented by analysis of a time series of key variables, which permits us to address the empirical regularities that must be explained to understand economic growth in Uruguay.

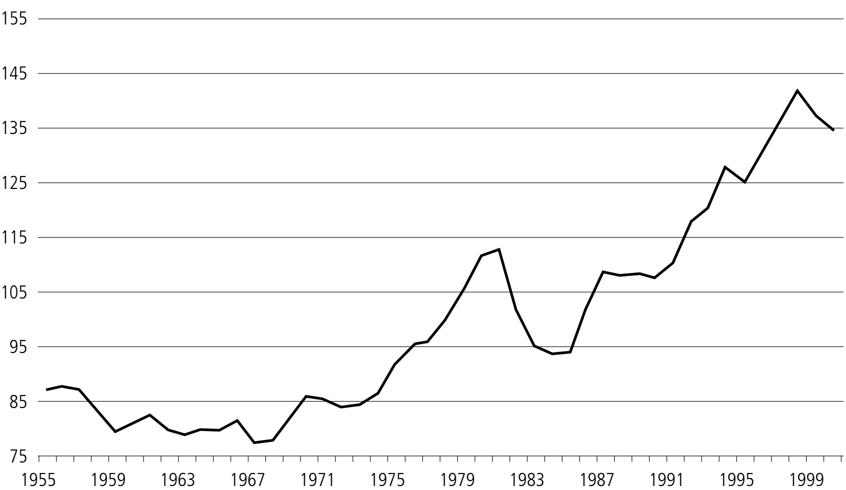
Next a model is formulated that is consistent with the stylized facts that have been documented. Given the absence of observed changes in TFP, the growth dynamic will not be driven by innovation and technological progress. Instead an "imbalance effect" along the lines of Barro and Sala-i-

Martin (1995, chapter 5) or Stokey (1996) is proposed, but in a model of a small open economy in which three goods are produced (two tradables and one nontraded) with the use of three factors of production: skilled and unskilled labor and physical capital. A change in commercial policy will modify the initial relative factor intensities, and the economy will face a transition to a new equilibrium during which output growth will be higher than in steady state. This model is then empirically implemented and tested. The importance of the more competitive environment that Uruguayan firms faced after the implementation of Mercosur in the 1990s is addressed, being reflected in a higher accumulation of human capital and a progressive reduction of the physical to human capital ratio during the decade. Conclusions follow.

Overview of Economic Policies

The evolution of per capita GDP in Uruguay clearly reflects the implementation of economic policies and their results. Figure 8.1 shows two distinct periods: the stagnation of 1955–73 and the resumption of growth from 1974 to the present.

Figure 8.1. GDP Per Capita
(index 1978 = 100)



As noted earlier, the first period was indelibly stamped by significant government intervention and high macroeconomic instability. After the Great Depression in 1930, Uruguay enacted, as did many other countries, a set of measures to control external commerce and equilibrate the balance of trade. Among the most notable measures were incremental tariffs and quotas and exchange rate controls. The ensuing reduction of imports helped local industry to develop, a tendency that was reinforced by the Second World War when international trade largely collapsed. The manufacturing sector experienced high growth rates during the 1940s, even after the end of the war, as the government consolidated its "import substitution" strategy by continuing to insulate local industry from renewed competition from abroad.

However, the ability of the Uruguayan economy to continue growing based on its domestic market was depleted by the end of the 1950s. At that moment, a new phenomenon appeared—surging inflation. In 1959 Congress passed a package of reforms to stabilize the economy by dismantling administrative controls on trade and exchange rate transactions. That plan finally collapsed in 1963 and was followed by a period of persistent fiscal deficits and recurrent exchange rate and balance-of-payments crises. Those external crises discouraged the government from following and extending the reforms of 1959. Indeed, the policy shifted to systematic introduction of new trade barriers and adoption of exchange rate controls.

Yet the combination of exchange rate crises and fiscal deficits fuelled inflation so that, on the brink of falling into hyperinflation, the government implemented a second stabilization plan in 1968–72. The initial phase of this plan induced expansion of domestic consumption and the highest GDP growth rates since the early 1950s. But that was merely a business cycle boom associated with the stabilization effort. Only in 1973, under pressure from the OPEC oil crisis and its negative impact on Uruguay's trade balance, did the government finally embrace economic measures aimed at promoting export growth while simultaneously liberalizing most nontariff barriers to imports. The exchange rate policy was also changed, establishing the total convertibility of the capital account of the balance of payments. Fiscal reform, which included introduction of a value-added tax (VAT), helped to bring down the budget deficit and reduce the previous tax regime's bias against exports.

The economic reforms of 1974–75 introduced a change in the trend of GDP, as Figure 8.1 clearly shows. GDP growth averaged 3.9 percent between 1973 and 1978, with a significant increment in net investment in construction and in machinery and equipment, as indicated in Figures 8.2 and 8.3. Exports also grew very rapidly in response to the new incentives and tracked the growth of imports in 1973–78 (Figure 8.4).

Government priorities returned to the problem of inflation in the second half of the 1970s, and in 1978 a third effort was launched to stabilize the inflation rate. This program used the preannouncement of the exchange rate as the nominal anchor (the "Tablita") in an attempt to make domestic inflation gradually converge to the rate of international inflation. Macroeconomic inconsistencies in the plan, combined with the 1981 Argentine currency crisis and the onset of the international debt problem, which interrupted the flow of capital to the region, brought the program to an end in 1982.

Figure 8.2. GDP Share of Total Net Investment
(in percent)

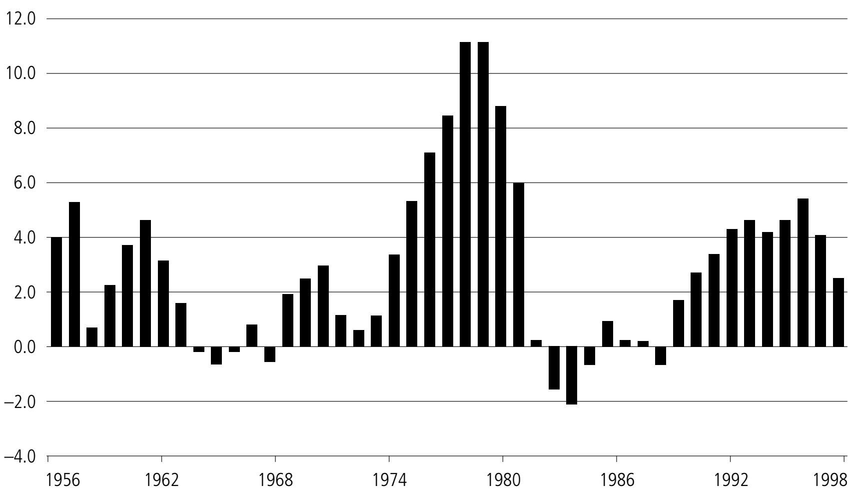


Figure 8.3. Net Investment in Construction and Machinery

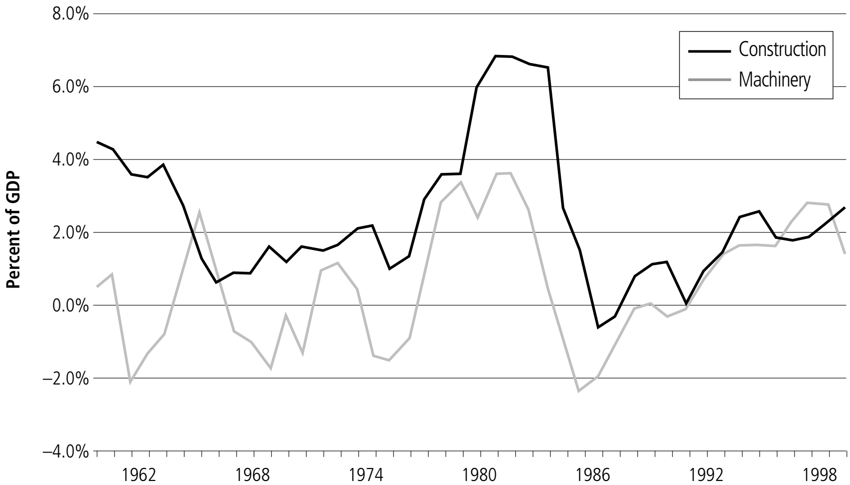
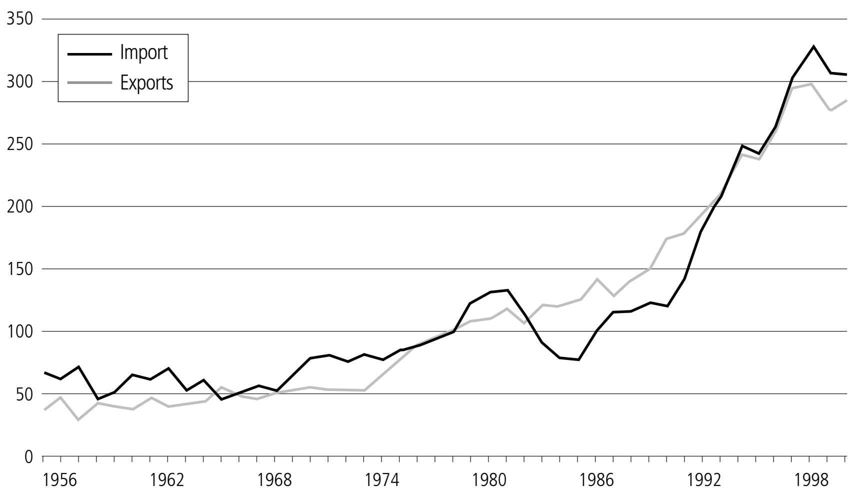


Figure 8.4. Exports and Imports
(1978 = 100)



Exit from the Tablita Plan prompted a deep crisis in the local financial market. The adverse domestic and external environment plunged the

Uruguayan economy into deep recession, perhaps the worst in the nation's history. GDP per capita fell 17.2 percent between 1981 and 1984, declining to its pre-1976 level.

Since then, the Uruguayan business cycle has been closely bound to the economic fortunes of its neighbors. In the mid-1970s, bilateral trade agreements were signed between Uruguay and Argentina and Brazil (agreements known as CAUCE and PEC, respectively), and in 1985 they were widened in scope. These preferential trade agreements deepened the natural dependency of the Uruguayan economy on what happened regionally, and the culmination of that process was the Mercosur agreement, launched by the Asunción Treaty in 1991.

Regional influence on the domestic business cycle is readily noticeable, particularly in relation to stabilization plans in Argentina and Brazil. The expansion of domestic demand in those countries after the implementation of the Austral and Cruzado plans was a crucial drag that helped pull Uruguay from economic recession in 1986–87. Again in 1991, Argentina's convertibility plan provided a strong push to its domestic demand that spilled over, in part, to Uruguay. Something similar happened in 1994 with the Plan Real in Brazil. On the other hand, when the Argentine and Brazilian economies suffered in 1995 after the Tequila effect and in 1999 after the Brazilian devaluation, Uruguay's economy also suffered.

Economic policies during the 1990s were oriented to consolidate the market-oriented reforms begun in the mid-1970s. Before implementation of Mercosur, Uruguay finalized the process of reducing tariffs that had begun in 1978 and eliminated most nontariff import barriers that had survived the initial abolition (Figure 8.5). As a result of the unilateral reduction of trade barriers and the expansion of trade in Mercosur, the openness ratio of the Uruguayan economy has shown a steady increase during the last 25 years (Figure 8.6).

There have also been attempts to promote public sector reforms, introducing new regulatory frameworks that enable the private sector to participate in the financing and operation of public sector projects in areas like telecommunications and energy. Similarly social security reform has allowed private sector firms to operate like pension funds.

Figure 8.5. Uruguayan Unilateral Tariff Reductions
(maximum levels)

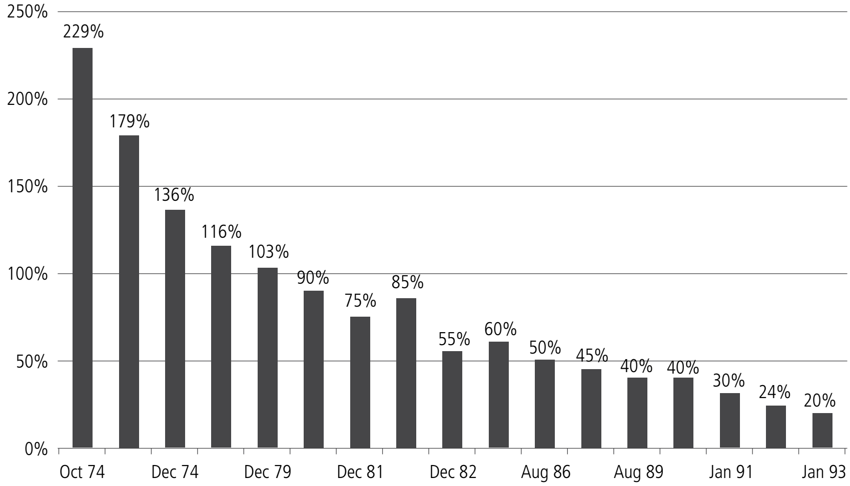
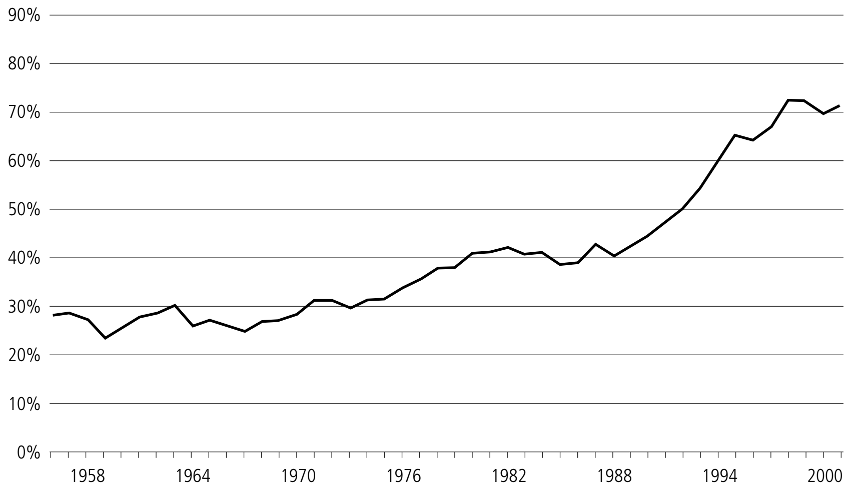


Figure 8.6. Openness Ratio
(exports plus imports as a share of GDP)



Growth Decomposition and Time Series Data

Having summarized the economic history of Uruguay during the last five decades, it is time to analyze the determinants of economic growth. The previous analysis emphasized the behavioral change in the economy after reforms in the 1970s; now we turn to assessing the factors behind the growth performance.

First, a decomposition of the sources of growth will be conducted to help understand the degree to which variation in GDP per capita is linked to changes in factor accumulation or to productivity improvements from innovation and technological progress.

Second, a closer look will be taken at key variables. In particular, it will be useful to know which variables have effectively changed their behavior since the introduction of economic reforms.

Growth Accounting

Assume that the production function of the economy can be characterized as

$$Y_t = A_t F\left(L_t h_t, K_t\right), \tag{8.1}$$

where Y is aggregate output or GDP, K is physical capital, L is labor, h is a correction for workforce quality (which this chapter always interprets as an index of human capital), and A is an index of productivity or technological change that evolves over time.

Totally differentiating this production function, the rate of growth is determined by

$$\hat{Y}_t = \hat{A}_t + \frac{\left(\frac{\partial F}{\partial Lh} L_t h_t\right)}{Y_t}\left(\hat{L}_t + \hat{h}_t\right) + \frac{\left(\frac{\partial F}{\partial K} K_t\right)}{Y_t}\hat{K}_t \ . \tag{8.2}$$

If factors of production are paid their marginal product, then the elasticities are

$$\frac{\left(\frac{\partial F}{\partial Lh}L_t h_t\right)}{Y_t}, \tag{8.3a}$$

$$\frac{\left(\frac{\partial F}{\partial K}K_t\right)}{Y_t}, \tag{8.3b}$$

which represent the share of labor and capital in the total product, respectively. Assuming constant returns to scale, then

$$\frac{\left(\frac{\partial F}{\partial Lh}L_t h_t\right)}{Y_t} + \frac{\left(\frac{\partial F}{\partial K}K_t\right)}{Y_t} = 1\,. \tag{8.4}$$

Given the data on GDP growth, factor shares, and the labor force and estimations of physical and human capital, the changes in total factor productivity $\hat{A}_t$ are estimated as a residual. GDP growth and factor shares are taken from the national accounts. Labor force is defined as labor employed, with data coming from the National Institute of Statistics.

Elías (1996) was updated to construct the series for physical capital. The human capital series was constructed using the labor-income-based measure suggested by Mulligan and Sala-i-Martin (1995).[2] The evolution of this variable is shown in Figure 8.7.

The results are presented in Table 8.1. Aggregate output growth averaged 1.8 percent yearly in the period under consideration. Prior to 1973, the average rate of growth was 0.7 percent, while during 1974–99 GDP growth averaged 2.6 percent. Growth during the Mercosur era—3.5 percent a year—was especially notable.

[2] Mincer regressions of labor income on a constant, years of education, years of labor experience and its square, and a dummy for sex were run for each year from 1982 to 1999, using data from the Households Survey. The constant term represents the estimated labor income for the noneducated, inexperienced male and can be interpreted as the unskilled-worker wage. The human capital index is defined, for each year in the sample, as the ratio of the average labor income in the sample to the constant term in the regression. Prior to 1982, evolution of the human capital index was estimated through the years-of-schooling variable in the Barro-Lee data set.

Figure 8.7. Human Capital Index
(1978 = 100)

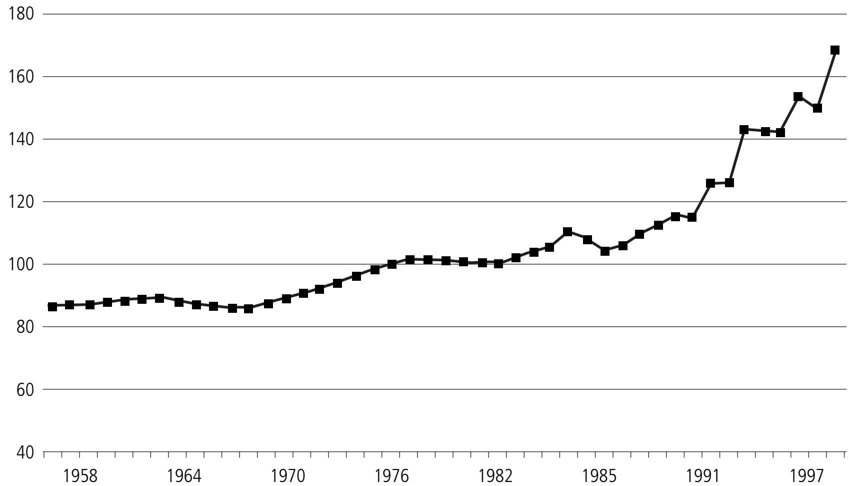


Table 8.1. Sources of Growth in the Uruguayan Economy (1957–99)

Period	GDP growth	Employment	Incidence of labor quality	Total	Incidence of capital	Total factor productivity
Change (%)						
1957–99	1.8	0.5	0.9	1.4	1.1	–0.69
1957–73	0.7	0.6	0.4	1.0	0.8	–1.07
1974–99	2.6	0.5	1.1	1.6	1.4	–0.45
1974–90	2.1	0.4	0.5	0.9	0.9	0.28
1991–99	3.5	0.7	2.5	3.2	2.2	–1.86
Contribution to GDP growth (%)						
1957–99	100	29.3	46.6	76.3	61.6	–37.8
1957–73	100	88.5	52.7	141.7	104.4	–146.2
1974–99	100	18.3	44.6	63.3	54.2	–17.5
1974–90	100	18.5	25.2	43.9	42.4	13.7
1991–99	100	18.7	71.6	91.1	61.7	–52.8

Source: Author's calculations.

During the low growth of 1957–73, almost all of the increment in production was explained by employment since GDP per worker remained constant during the period. Increments in the quality of labor, measured as an index of human capital, explained nearly 50 percent of GDP growth during the entire period. In the 1990s this human capital concept explained more than two-thirds of output growth. A lower incidence occurred during 1974–90, when its contribution to output growth was 25 percent.

Accumulation of capital also played an important role in output growth. Higher rates of output growth were achieved in the 1990s, when human capital accumulation grew even faster.

An unexpected result is that, except in 1974–90, TFP showed negative rates of growth in almost all subperiods (and an average decrease of 0.7 percent annually across the whole period). Figure 8.8 shows the computed series for TFP. It reveals no changes in trend or level for the entire period, a result confirmed in the time series analysis.

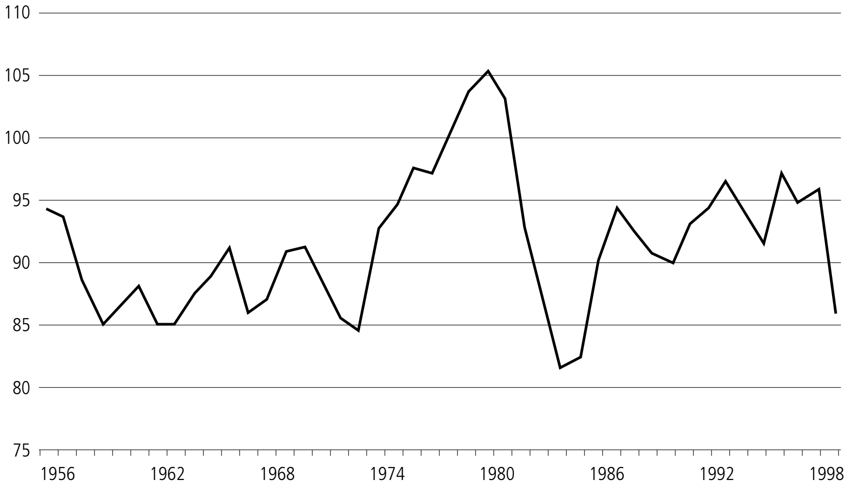
The growth accounting exercise suggests that factor accumulation was the dominant contributor to economic growth. The rate of growth in factor accumulation seems related to the major changes in the economic environment during the past five decades: the set of economic reforms in the mid-1970s and the implementation of Mercosur in the 1990s. A closer look at the series involved will shed additional light on this analysis.

Time Series Evidence

An important way of assessing impact from economic policies on growth is to determine if changes in variables under government control provoke a change in the *level* or in the *differences* of aggregate output. The first result is usually found in comparative static analyses of changes in trade policy, factor endowments, or other shocks. In this case, the change in policy affects the level of output and its transitory rate of growth. Finally, however, the rate of growth returns to the initial values. This is also the conclusion of neoclassical growth models, in which a change in the variables that determine a steady state induces an increment of the level of output per worker in the long run, but no change in the steady-state rate of growth.

Typically in endogenous growth models, a change in a policy variable permanently affects the rate of growth or the difference of the series. This section will address what outcome, given the characteristics of the se-

Figure 8.8. Total Factor Productivity Index
(1978 = 100)



ries under analysis, could be expected to happen in Uruguay after economic reforms.

The evolution of the TFP level in Figure 8.8 suggests no change in the mean of this variable during the period under analysis. But this also seems to be so for the net investment variables in Figures 8.2 and 8.3. If these variables were indeed stationary around some mean, then the change in policies would have modified the level of the physical capital, but with no long-run changes for the variable's rate of change.

To address this issue, unit root tests for the variables of interest were performed. Table 8.2 shows the augmented Dickey-Fuller tests of the form

$$\Delta Y_t = \beta_0 + \beta_1 t + (\alpha - 1) Y_{t-1} + \sum_{i=1}^{k} \Delta Y_{t-1}. \qquad (8.5)$$

With the exception of TFP and the index of human capital, all the series in levels under analysis have unit roots. The index for TFP is stationary around a nonzero mean, while the index of human capital looks, at least, integrated at order two.

Table 8.2. Augmented Dickey-Fuller Test Results

Variable	Differences	Constant	Trend	ADF *t*-test	Lags
GDP per worker	0			1.2633	0
	1	0.00764		–5.5308***	0
		(1.0896)			
Human capital index	0	–0.2119	0.0080	0.6132	1
		(–0.6457)	(0.8156)		
				–0.3183	4
Machinery and equipment	0			0.5114	1
per worker	1			–4.0815***	0
Private fixed capital	0			0.1350	0
	1	0.0008		–6.1171***	0
		(0.1343)			
Public construction	0			2.1708	0
	1	0.0118		–5.3357***	0
		(1.7547)			
Total factor productivity	0	1.6321		–3.4226**	1
		(3.4179)			

**Significant at 5% level.
*** Significant at 1% level.

In particular, GDP in levels is integrated at order one, and so its differences (or GDP growth) are a stationary series around a mean. This implies that the output growth mean is not significantly different before and after the 1970s reforms. Those reforms induced an increment in the output level but not in the steady-state growth rate.

A similar conclusion can be deduced with respect to the various measures of physical capital. The stock of total fixed private capital is integrated at order one, but its differences, the net investment in those items, are stationary. So it can be concluded that the reforms did not affect the equilibrium investment rate but increased it temporarily while the steady-state value of the capital stock was obtained.

The series for human capital deserves close attention. It is the only variable of all those considered, except TFP, whose rate of change is not stationary. To check whether the nonstationariness of changes in human capi-

Table 8.3. Perron Tests for Structural Breaks

Variable	Differences	Model	Perron *t*-test	Lags
GDP per worker	0	AO	–3.196	0
Human capital index	0	AO	–3.759**	
	1	IO	9.472***	0
Machinery and equipment per worker	0	AO	–2.479	1
Private fixed capital	0	AO	–3.395	0

Note: Model AO refers to the "additive outlier model" of Perron, in which there is change in slope but no change in the intercept. IO refers to the "innovative outlier" model, in which there is a change in the intercept but no change in slope.
** Significant at the 5% level.
*** Significant at the 1% level.

tal results from a structural time break, the Perron test for unit roots under structural breaks was performed. The results are presented in Table 8.3.

After analysis of data not reported here, the only significant structural change found in the index-of-human-capital series was in 1991, following introduction of Mercosur. When a change in trend is introduced to capture the effect of a deterministic movement in the series, the null hypothesis of a unit root in the series in levels is not rejected at a 5 percent significance level. But the trend change from 1991 is significant enough to make the differenced series stationary when that change is taken into account.

Finally, with the exception of the TFP series, which is stationary in levels, all the analyzed series are integrated at order one, and so their first differences are stationary. In the case of the index of human capital, the stationariness of the series in differences is obtained after a correction is made for a jump of the series in differences (a change in trend in the series in levels) since 1991.

Given this series behavior, the increment in the output growth rate after episodes of liberalization, like the reforms of the mid-1970s or the later implementation of Mercosur, is a transitory phenomenon that tends to be reversed unless new shocks occur.

These variables tell a story consistent with the traditional neoclassical growth model, with a steady state and an invariant growth rate despite changes introduced in the model's parameters. Evolution of the human and physical capital can be interpreted as the response of one factor to a favorable change in relative prices. If more-skilled workers are attracted to sectors in expansion, whether due to better relative prices or technology improvements, a transformation from unskilled to skilled workers through better education will occur, and the equilibrium ratio between capital and labor will be modified. In the case of Uruguay, the time series evidence supports the hypothesis that the more competitive environment after introduction of Mercosur in the 1990s changed the relative demand of factors since sectors that produced commodities with high intensities of unskilled workers and physical capital begin to slow down. This change in demand would be reflected in the wage differential between skilled and unskilled workers, attracting a higher proportion of well-educated people.

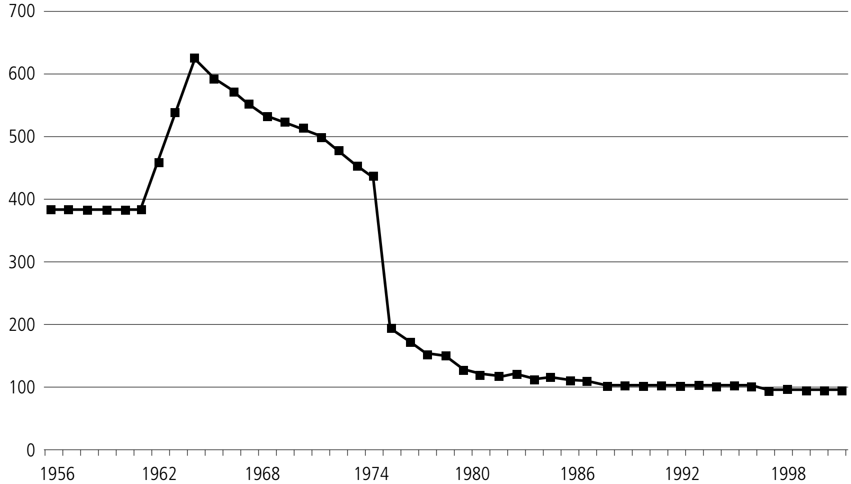
Since the ratio between skilled workers and the other factors is low in comparison with equilibrium values, the return to human capital will be higher (as is happening in Uruguay) and will decrease as the economy approaches equilibrium. During that transition, as capital and labor are reallocated to the sectors with higher productivity, the aggregate product will also rise.

Analyzing the extent to which changes in factor demand are related to the new economic environment facing the Uruguayan economy after the 1970s requires a measure for the policy variables characterizing the liberalization process. An index of nominal protection for the period under analysis was constructed, and the results are presented in Figure 8.9.[3]

[3] For 1988–2000, the indexes of prices of imported products calculated by the Instituto Nacional de Estadística (INE) provide an excellent measure. This office calculates two indexes of imported product prices: one for CIF (cost, insurance, and freight) prices and one for prices in terms of the importer deposit. Both indexes are calculated for the same basket of goods, so the ratio of the index of prices at deposit to the index of prices CIF gives the evolution of the costs incurred to nationalize the merchandise, including tariffs. This permits one to avoid the problem of representing trade policy through the nominal tariff during the 1990s, when almost 50 percent of Uruguay's international trade had preferential tariff treatment due to Mercosur.

The evolution of tariffs better describes Uruguayan commercial policies prior to the 1990s. After the trade reform in the late 1970s, there are good measures of average nominal protection (which includes tariffs and other nontariff policy instruments), extensively documented in Rama (1982), CINVE (1987), Macadar (1988), and De Brun and Michelin (1993). For the period before trade liber-

Figure 8.9. Index of Nominal Protection



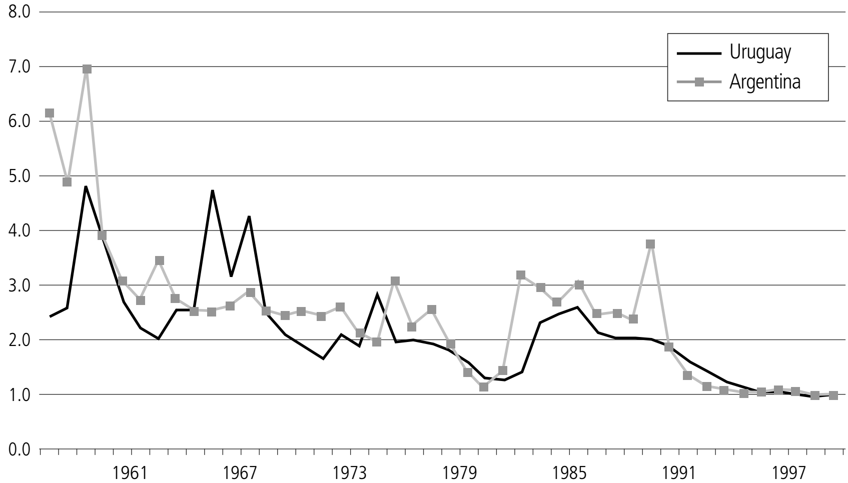
The index of nominal protection gives an indicator of the evolution of the relative price of importables during the period under consideration. But in an economy with three goods (exportable, importable, and nontradable) another important relative price is the real exchange rate, defined as the relative price of tradables to nontradables.

In the case of Uruguay, the real exchange rate supplies the channel through which regional macroeconomic shocks, especially those from Argentina, affect the Uruguayan business cycle. Figure 8.10 clearly shows the strong relationship between the real exchange rate of Argentina and Uruguay, which was formally addressed through a cointegration analysis not reported in this chapter. Since the domestic markets of both countries are highly integrated due to intense cross-border movement of people (for tour-

alization, measures of nominal protection are more difficult to obtain because of the multiplicity of nontariff trade barriers like quotas, import prohibitions, multiple exchange rate mechanisms, and exchange rate controls, among others. Favaro and Spiller (1990) estimated protection for that period based on the ratios of import to export prices for a sample of goods, which were used to compute a trade policy index.

After obtaining measures of nominal protection in the period under consideration, the index of tariff policy was calculated by adding 1 to the nominal protection percentage in year XX and assigning the value 100 to the year 1988.

Figure 8.10. Real Exchange Rate: Uruguay and Argentina



ism, business, or family ties), most goods and services usually considered to be nontradables face competition from close substitutes in the other country. This explains the tendency of both countries' real exchange rates to move together over the long run.

The appreciation of the real exchange rate in Argentina after the Convertibility Plan of 1991 induced a relative increment of the price of non-tradables in Uruguay during the last decade. This change in relative prices was added to the one generated by the trade liberalization process, which, under certain conditions of factors demand, can result in the shift of the human to physical capital ratio observed in the last 10 years and a temporary acceleration of the rate of growth during the transition. The next section develops a model that reasonably encompasses these stylized facts. After that, the model is tested empirically to assess whether it can capture adequately the dynamics of the variables related to economic growth.

The Model

Consider a small open economy for which both the world price of traded goods and the world interest rate are taken as given. The economy produces three types of goods and services: traded goods (exportable and importable) are produced for consumption, investment in human and physical capital, or export, while nontraded goods are produced for domestic consumption and formation of human capital.

Three factors of production are used to produce these goods and services: skilled labor S, unskilled labor U, and physical capital K. Total labor force L, given by

$$L_t = S_t + U_t, \tag{8.6}$$

grows at the exogenous rate n. As in Stokey (1996), the distinction between skilled and unskilled workers tries to capture two kinds of productive services provided by labor (i.e., physical and mental effort).

Consumption and Human Capital Formation

Households are the direct owners of physical capital, which they rent to firms at a rate r, equal to the world interest rate. They can also receive loans from foreign residents with no restrictions on foreign debt besides the intertemporal budget constraint. Then, net assets per capita in this economy are represented by

$$a_t = k_t - d_t, \tag{8.7}$$

where d is net debt to foreigners (in per capita terms) and

$$k_t = \frac{K_t}{L_t}. \tag{8.8}$$

They also supply labor inelastically, but they choose the resources dedicated to human capital formation and, in this way, the amount of skilled and unskilled labor available.

The household's problem, given the initial endowments of assets and human capital and given the paths for factor and final product prices, is to choose paths for investment in physical and human capital, total expenditure and its allocation among the different goods and services, to maximize discounted utility:

$$U_0 = \int_0^\infty e^{-(\rho - n)t} \log u\left(c_{N,t}, c_{X,t}, c_{M,t}\right) dt \tag{8.9}$$

$$\text{s.t.} \quad \dot{a}_t = W_{U,t} + z_t\left(W_{S,t} - W_{U,t}\right) + (r - n)a_t - \varepsilon_t + v_t - i_{z,t},$$

where ρ is the rate of time preference; skilled and unskilled wages are $W_j, j = S,U$; per capita consumption of nontradables, exportables, and importables is c_i, $i = N,X,M$; government transfers are represented by v, financed through the commercial policy

$$z = \frac{S}{L};$$

and i_z is nominal expenditure in human capital formation.

Let us assume that the world interest rate is $r = \rho$, a rate that would apply in steady state if the economy were closed. The representative household can borrow and lend at world interest rate r, so its investment and consumption decisions can be analyzed separately, in three stages. First, the path for human capital formation is determined to maximize the present discounted value of its labor income flow, net of investment costs. Second, given the optimal supply of skilled and unskilled labor, the path of aggregate expenditure on consumption goods is chosen to maximize lifetime utility. Third, given the prices of final goods, expenditure is allocated among nontradable, exportable, and importable goods.

Investment in Human Capital and the Consumption Path

The optimal path of expenditure in human capital formation is the one that maximizes V_0, given z_0, v, W_S and W_U, so that

$$V_0 = \int_0^\infty e^{-(r-n)t}\left[W_{U,t} + z\left(W_{S,t} - W_{U,t}\right) + v_t - i_{z,t}\right] dt \tag{8.10}$$

$$\text{s.t.} \quad \dot{z}_t = B i_{z,t}^{\phi} - \eta z_t,$$

where $B > 0$, $0 < \eta < 1$, (depreciation rate), and $0 < \phi < 1$ are constants. The law of motion for z indicates the rate at which labor is transformed from unskilled to skilled. As in Stokey (1996), the parameter ϕ represents the adjustment cost.

We can analyze this optimization problem by setting up the current-value Hamiltonian:

$$J = e^{-(r-n)t}\left[W_U + z\left(W_S - W_U\right) + v_t - i_z + q\left(Bi_z^{\phi} - \eta z\right)\right], \tag{8.11}$$

where q is the current-value shadow price of the proportion of skilled workers in the total labor force. The first-order conditions of this optimization problem give the following laws of motion for human capital and its shadow price:

$$\dot{z} = \left[B\left(\phi q\right)^{\phi}\right]^{\frac{1}{1-\phi}} - \eta z, \tag{8.12a}$$

$$\dot{q} = \left(r - n + \eta\right)q - \left(W_S - W_U\right). \tag{8.12b}$$

The steady-state values of z, i_z, and q satisfy

$$\tilde{z} = \frac{1}{\eta}\left[B\left(\phi\tilde{q}\right)^{\phi}\right]^{\frac{1}{1-\phi}}, \tag{8.13a}$$

$$\tilde{i}_z = \left[B\phi\tilde{q}\right]^{\frac{1}{1-\phi}}, \tag{8.13b}$$

$$\tilde{q} = \frac{W_S - W_U}{r - n + \eta}. \tag{8.13c}$$

The phase diagram of this system (available from the author upon request) shows that the only stable path goes through the $\dot{q} = 0$ locus, so the shadow price of human capital remains constant during the transition to a steady state. This means that if there is a change in relative wages, the shadow price q will jump on impact to its new steady-state value, and then z will increase or decrease gradually to its new equilibrium.

We can now proceed to the determination of the optimal consumption path. Define the consumption index as

$$c = \left[\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}\right]^{-1} c_N^{\alpha} c_X^{\beta} c_M^{1-\alpha-\beta} \tag{8.14}$$

and the instantaneous utility function as $u\left(c_N, c_X, c_M\right) = c$. If we replace $u\left(c_N, c_X, c_M\right)$ with the indirect utility given by

$$v\left(P_N, P_X, P_M; \varepsilon\right) = \frac{\varepsilon}{P}, \tag{8.15}$$

where P is the perfect price index $P = P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}$ the optimization problem (8.9) can be expressed as

$$U_0 = \int_0^{\infty} e^{-(\rho-n)t}\left(\log\varepsilon - \log P\right)dt \tag{8.16}$$

$$\text{s.t. } \dot{a}_t = W_{U,t} + z_t\left(W_{S,t} - W_{U,t}\right) + \left(r-n\right)a_t - \varepsilon_t + v_t - i_{z,t},$$

where a_0 and the path of z, $i_{z,t}$, P_i, $i = N, X, M, W_S$ and W_U are taken as given. The first-order conditions of this problem determine that the optimal path for spending satisfies

$$\frac{\dot{\varepsilon}}{\varepsilon} = r - \rho. \tag{8.17}$$

Given the assumption that $r = \rho$, the solution to this problem is a constant consumption spending, whose level is determined by integrating the differential equation in (8.16), assuming a non-Ponzi-game condition, and using the optimal value of V_0 found in the first stage:

$$\tilde{\varepsilon} = \left(r-n\right)\left(V_0 - a_0\right). \tag{8.18}$$

Allocation of Consumption

Having obtained the optimal path for per capita spending, the constant level $\tilde{\varepsilon}$ in (8.18), the allocation of consumption to nontradable, exportable, and importable goods can be determined by maximizing the instantaneous utility function

$$u(\cdots)=\left[\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}\right]^{-1}c_N^{\alpha}c_X^{\beta}c_M^{1-\alpha-\beta} \tag{8.19}$$

$$\text{s.t. } P_N c_N + P_X c_X + P_M c_M = \tilde{\varepsilon}.$$

The first-order conditions of this problem determine the sectoral demands, as follows:

$$c_N = \alpha\frac{\tilde{\varepsilon}}{P_N}, \tag{8.20a}$$

$$c_X = \beta\frac{\tilde{\varepsilon}}{P_X}, \tag{8.20b}$$

$$c_M = (1-\alpha-\beta)\frac{\tilde{\varepsilon}}{P_M}. \tag{8.20c}$$

Finally, define the index of consumption of the tradables composite and the perfect price index for tradable goods as

$$c_T = \left[\frac{\beta^{\frac{\beta}{1-\alpha}}(1-\alpha-\beta)^{\frac{1-\alpha-\beta}{1-\alpha}}}{1-\alpha}\right]^{-1} c_X^{\frac{\beta}{1-\alpha}} c_M^{\frac{1-\alpha-\beta}{1-\alpha}}, \tag{8.21a}$$

$$P_T = P_X^{\frac{\beta}{1-\alpha}} P_M^{\frac{1-\alpha-\beta}{1-\alpha}}. \tag{8.21b}$$

Production and Equilibrium

The sector that produces nontraded goods employs skilled labor as the only input, while the exportable good is produced combining skilled labor and physical capital, and the importable good is produced combining unskilled labor and physical capital. As in Baldwin and Seghezza (1996), physical capital formation requires the tradable composite c_T, while human capital formation requires the aggregate composite *c*. That is, spending in physical capital combines the use of the exportable and importable good in proportions

$$\frac{\beta}{1-\alpha} \text{ and } \frac{1-\alpha-\beta}{1-\alpha},$$

respectively, while spending in human capital combines the three products in proportions α for nontraded goods, β for exportables, and $1-\alpha-\beta$ for importables.

This specification seeks to capture the general fact that nontraded goods like services are, in general, relatively intensive in human capital while manufactured goods (usually traded goods) are more capital intensive. Each of the two sectors manufacturing tradable goods makes intensive use of a different type of labor, which will be reflected in this economy's pattern of trade. To highlight the role played by cross-sectoral differences in factor intensities on the pattern of trade, the differences are made as extreme as possible, and each tradable sector employs only one labor type. Changes in the relative price of the traded goods will influence the formation of human capital.

All markets are competitive. All goods and services are produced with constant-returns-to-scale technologies. The production functions for the nontradable, exportable, and importable goods, respectively, are

$$Y_N = A_N S_N, \tag{8.22a}$$

$$Y_X = A_X K_X^{\gamma} S_X^{\gamma}, \tag{8.22b}$$

$$Y_M = A_M K_M^{\gamma} S_M^{\gamma}, \tag{8.22c}$$

where Y_i, $i = N,X,M$, represent physical quantities of production in each sector, A_i, $i = N,X,M$, are constants, and $U_M = U$, $S_X + S_N = S$, and $K_X + K_M = K$. There is no technological change in this economy since our main interest is to capture the effect on growth dynamics of a change in resource allocation.

Given the world interest rate r, the depreciation rate of physical capital δ, the world prices of the tradable goods P_i, $i = N,X,M$, and the skilled and unskilled wages W_j, $j = S,U$, the first-order conditions for the allocation of resources in the three sectors are the following:

$$P_N A_N = W_S, \tag{8.23a}$$

$$P_X A_X \gamma \left(\frac{z_X}{k_X} \right)^{1-\gamma} = P_T (r + \delta), \tag{8.23b}$$

$$P_X A_X (1-\gamma) \left(\frac{k_X}{z_X} \right)^{\gamma} = W_S, \tag{8.23c}$$

$$P_M A_M \gamma \left(\frac{1-z}{k_M} \right)^{1-\gamma} = P_T (r + \delta), \tag{8.23d}$$

$$P_M A_M (1-\gamma) \left(\frac{k_M}{1-z} \right)^{\gamma} = W_U. \tag{8.23e}$$

In equations (8.23c) and (8.23e) the price of a unit of physical capital is the tradable composite index. All stocks are expressed in per capita terms, so

$$z_X = \frac{S_X}{L}, \tag{8.24a}$$

$$z_N = \frac{S_N}{L}, \tag{8.24b}$$

$$1 - z = \frac{U}{L}, \tag{8.24c}$$

$$z_X + z_N = z, \tag{8.24d}$$

$$k_X = \frac{K_X}{L}, \tag{8.24e}$$

$$k_M = \frac{K_M}{L}, \tag{8.24f}$$

and

$$k_X + k_N = k = \frac{K}{L}. \tag{8.24g}$$

The first-order conditions for optimal factors demand (8.23), the sectoral production functions (8.23) and the aggregate demand functions for final goods derived from (8.20) determine the nontraded-good equilibrium price P_N; nominal skilled and unskilled wages $W_j, j = S,U$; sectoral allocation of skilled labor z_i, $i = N, X$, and unskilled labor $1 - z$; and sectoral allocation of physical capital k_i, $i = X, M$; given world prices of traded goods P_i, $i = X, M$, and the expenditure path in consumption goods $\tilde{E} = \tilde{\varepsilon}L$.

Equilibrium in the market of nontraded goods requires the following condition:

$$P_N Y_N = P_N C_N + \alpha I_Z, \tag{8.25}$$

where $C_N = C_N L$ and $I_z = i_z L$. Using equation (8.20a) and the production function (8.22a), the aggregate demand of labor in the nontradable sector is obtained:

$$S_N = \alpha \frac{E + I_Z}{A_N}, \tag{8.26}$$

or in per capita terms,

$$\tilde{z}_N = \alpha \frac{\tilde{\varepsilon} + \tilde{i}_z}{A_N}, \tag{8.27}$$

where $\tilde{\varepsilon}$ and $\tilde{i}_z$ come from (8.18) and (8.13b), respectively.

Wage equations for skilled and unskilled labor result from first-order conditions (8.23b–e). Combining equations (8.23b–c), the skilled wage is obtained:

$$\tilde{W}_S = P_X \left[\gamma^{\gamma} (1-\gamma)^{1-\gamma} A_X \left(\frac{P_X}{P_M} \right)^{\frac{(1-\alpha-\beta)\gamma}{1-\alpha}} \left(\frac{1}{r+\delta} \right)^{\gamma} \right]^{\frac{1}{1-\gamma}}. \tag{8.28}$$

The unskilled wage equation is obtained in a similar way from conditions (8.23d–e):

$$\tilde{W}_U = P_M \left[\gamma^{\gamma} (1-\gamma)^{1-\gamma} A_M \left(\frac{P_M}{P_X} \right)^{\frac{\beta\gamma}{1-\alpha}} \left(\frac{1}{r+\delta} \right)^{\gamma} \right]^{\frac{1}{1-\gamma}}. \tag{8.29}$$

The equilibrium ratio $\tilde{W}_S / \tilde{W}_U$ results from dividing (8.28) and (8.29) and equals

$$\frac{\tilde{W}_S}{\tilde{W}_U} = \left(\frac{A_X P_X}{A_M P_M} \right)^{\frac{1}{1-\gamma}}. \tag{8.30}$$

From equation (8.23a), the price of the nontraded good is immediately obtained using the result for the skilled wage in (8.28):

$$\tilde{P}_N = \frac{\tilde{W}_S}{A_N}. \tag{8.31}$$

Equilibrium ratios of capital to labor in the exportable and the importable sectors can be expressed, using equations (8.23c), (8.23e), (8.28), (8.29), and (8.30), as

$$\left(\frac{\tilde{k}_X}{\tilde{z}_X}\right) = \left(\frac{1}{A_X(1-\gamma)}\frac{\tilde{W}_s}{P_X}\right)^{\frac{1}{\gamma}}, \tag{8.32a}$$

$$\left(\frac{\tilde{k}_M}{1-\tilde{z}}\right) = \left(\frac{1}{A_M(1-\gamma)}\frac{\tilde{W}_U}{P_M}\right)^{\frac{1}{\gamma}}. \tag{8.32b}$$

From conditions (8.23b) and (8.23d), the following relation between relative factor intensities result, taking into account the value of $\tilde{W}_S / \tilde{W}_U$ in (8.30):

$$\left(\frac{\tilde{k}_X}{\tilde{z}_X}\right) = \frac{\tilde{W}_S}{\tilde{W}_U}\left(\frac{\tilde{k}_M}{1-\tilde{z}}\right). \tag{8.33}$$

Therefore, if we assume that skilled wages must be higher than unskilled wages, then the exportable sector will have a higher capital-to-labor ratio than the importable sector.

Effects of Changes in Trade Policy

The model analyzed here has the well-known properties of neoclassical growth models in which the economy converges to a steady state with zero per capita growth. The interest here is to analyze the economic dynamic after a change in the predetermined variables, due, for example, to a trade policy modification that affects the relative price of the exportable to the importable good

$$\frac{P_X}{P_M},$$

where if we represent with an asterisk the variables at international prices and if τ is the import tariff, then

$$P_X = P_X^* \text{ and } P_M = P_M^*(1+\tau). \tag{8.34}$$

We will assume that $\hat{P}_X$ - $\hat{P}_M$ is positive, for example, because of a reduction in trade barriers. The symbol ^ over a variable denotes the rate of change of that variable; that is,

$$\hat{X} = \frac{dX}{X}.$$

Changes in Relative Prices

The impact of a change in the relative price of the exportable good on factor retributions, taking the world interest rate as given, resembles the well-known results of the Stolper-Samuelson theorem. The relative change in the skilled wage in terms of exportables and in the unskilled wage in terms of importables can be expressed as

$$\hat{W}_S - \hat{P}_X = \frac{(1-\alpha-\beta)}{1-\alpha}\frac{\gamma}{1-\gamma}\left(\hat{P}_X - \hat{P}_M\right) > 0, \qquad (8.35a)$$

$$\hat{W}_U - \hat{P}_M = -\frac{\beta}{1-\alpha}\frac{\gamma}{1-\gamma}\left(\hat{P}_X - \hat{P}_M\right) < 0. \qquad (8.35b)$$

As in the Stolper-Samuelson theorem, if

$$\hat{P}_M = -\frac{d\tau}{(1-\tau)} < 0 \qquad (8.36)$$

because the government reduces the import tariff, keeping P_X constant, then it can be shown from (8.35a) and (8.35b) that $\hat{W}_X > \hat{P}_X > \hat{P}_M > \hat{W}_U$, with $\hat{W}_U < 0$.

It will be useful to find an expression for the rate of change of the ratio of skilled wages to unskilled wages:

$$\frac{\tilde{W}_S}{\tilde{W}_U}.$$

From (8.35a) and (8.35b) the following expression is obtained:

$$\hat{W}_S - \hat{W}_U = \frac{\hat{P}_X - \hat{P}_M}{1-\gamma} > 0. \tag{8.37}$$

Since $0 < \gamma < 1$, the change in the ratio of wages due to a change in final goods prices is magnified, and $\hat{W}_S - \hat{W}_U > \hat{P}_X - \hat{P}_M$.

The change in the price of the nontraded good follows from equation (8.31) and is equal to the rate of change of skilled wages:

$$\hat{P}_N = \hat{W}_S. \tag{8.38}$$

Changes in Skilled Labor and Its Allocation

Having determined the effect of trade policy on wages and the prices of domestic goods, its impact on factor demand can be analyzed. Beginning with the effect of a change in the relative price of exportables on human capital accumulation, equations (8.13a) and (8.13c) give the following expression for the rate of change in the participation of skilled workers in the total labor force *z*:

$$\hat{z} = \frac{\phi}{1-\phi}\frac{dW_S - dW_U}{W_S - W_U} = \frac{\phi}{1-\phi}\left[\hat{W}_S + \frac{W_U}{W_S - W_U}\left(\hat{W}_S - \hat{W}_U\right)\right] > 0, \tag{8.39}$$

as long as $\hat{W}_S > 0$ and $\hat{W}_S - \hat{W}_U > 0$, according to equations (8.35a) and (8.37) and the assumption that $W_S > \hat{W}_U$.

Even though the positive impact of the relative increment in the price of the exportable good on human capital accumulation comes directly from the assumptions made about the production functions, the allocation of more-skilled workers to production of the nontraded and the exportable good is more intriguing. As can be seen from equation (8.27), the participation of skilled workers in the nontradable sector $\tilde{z}_N$ depends on the equilibrium values of expenditure per capita $\tilde{\varepsilon}$ and investment in human capital $\tilde{i}_z$. The latter is obtained from (8.13b) and depends on the shadow price q, which jumps to its new steady-state value after a change in relative prices and remains constant thereafter. So $\tilde{i}_z$ will also jump to its new steady-state value and remain constant during the transition.

But $\tilde{\varepsilon}$ results from (8.18) and its change depends on the derivative of the integral (8.10). The present discounted value of the labor income stream plus transfers Ψ_0 is defined as follows:

$$\Psi_0 = \int_0^\infty e^{-(r-n)t}\left[W_{U,t} + z\left(W_{S,t} - W_{U,t}\right) + v_t\right]dt. \tag{8.40}$$

If $\tilde{i}_z$ remains constant during the transition to the new steady state, the integral (8.10) can be expressed as

$$V_0 = \Psi_0 - \frac{\tilde{i}_z}{r-n}. \tag{8.41}$$

The nominal expenditure per capita in consumption goods given by (8.18) is now

$$\tilde{\varepsilon} = (r-n)\left(\Psi_0 + a_0\right) - \tilde{i}_z, \tag{8.42}$$

and the equilibrium value of the proportion of skilled workers allocated to the nontradable-good sector is

$$\tilde{z}_N = \alpha\frac{(r-n)\left(\Psi_0 + a_0\right)}{A_N}. \tag{8.43}$$

The problem is now to find the derivative of the integral (8.40) for a change in wages, due to an increment in the relative price of the exportable good. Define the "average" wage as

$$W_1 = W_{U,t} + z\left(W_{S,t} - W_{U,t}\right), \tag{8.44}$$

and let

$$d\Psi_0 = \int_0^\infty e^{-(r-n)t}\left(dW_t + dv_t\right)dt,$$

where dv_t is the change in transfers that corresponds to the change in government revenues when the import tariff is modified. If $dW_t > 0$ and $dv_t > 0$ for all $t \in [0, \infty]$, then $d\Psi_0 > 0$ unambiguously and $\tilde{z}_N$ will increase. In the following discussion, it will be assumed that tariffs are high enough to promote an increase in revenues on impact, immediately after the reduction in tariffs levels. During the transition as *z* increases, production of importables will decrease and imports will grow, and so $dv_t > 0$ for all $t \in [0, \infty]$. We will now consider the effect on *dW*.

On impact at time 0, *z* remains constant, and so

$$dW_0 = dW_U + z(dW_S - dW_U). \tag{8.45}$$

Given that $dW_S - dW_U > 0$ from (8.37) and (8.39), this expression will always be positive if $dW_U > 0$. But we will consider the stringent condition $dW_U < 0$ for the extreme case in which $\hat{P}_X = 0$ and $\hat{P}_M < 0$. This would be the case for a reduction in import tariffs, without affecting the price received by the producers of the exportable good. Define the unskilled-wage component proportion in the average wage and the skilled premium as

$$m_U = \frac{W_U}{W}, \tag{8.46a}$$

$$m_S = 1 - m_U = \frac{z(W_S - W_U)}{W}, \tag{8.46b}$$

respectively. Then

$$\frac{dW_0}{W_0} = m_U \hat{W}_U + m_S \frac{dW_S - dW_U}{W_S - W_U}. \tag{8.47}$$

Recalling from equation (8.39) that

$$\frac{dW_S - dW_U}{W_S - W_U} = \hat{W}_S + \frac{W_U}{W_S - W_U}\left(\hat{W}_S - \hat{W}_U\right) > 0$$

and using equations (8.35a–b) under the hypotheses $\hat{P}_X = 0$ and $\hat{P}_M < 0$, dW_0/W_0 will be positive if

$$\frac{m_S}{1-m_S} > \frac{1-\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}{\dfrac{W_U}{W_S-W_U}+\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}. \tag{8.48}$$

The right-hand expression depends on the value of

$$\gamma\frac{1-\alpha-\beta}{1-\alpha}.$$

Its presence in this equation comes from the assumption that investment in physical capital is a composite of the tradable goods, being

$$\frac{1-\alpha-\beta}{1-\alpha},$$

the participation of the importable good in the formation of investment. As most of the investment in physical capital comes from the importable good, the right-hand side of (8.48) will decrease and less participation of the skilled labor premium in the average wage will be required to verify the equation.

After the initial impact, during the time interval $t \in (0,\infty]$, z will be growing along the stable saddle path. As the skilled and unskilled wages remain constant after the initial change, $dW_t > 0\ \forall t \in (0,\infty]$ from the initial value W_0. The change from the initial steady-state value of W to the new one is given by

$$\frac{d\tilde{W}}{\tilde{W}} = m_U\hat{W}_U + m_S\frac{d\tilde{W}_S - d\tilde{W}_U}{\tilde{W}_S-\tilde{W}_U} + m_S\frac{\phi}{1-\phi}\frac{d\tilde{W}_S - d\tilde{W}_U}{\tilde{W}_S-\tilde{W}_U}, \tag{8.49}$$

where the last term is obtained from the expression for $\hat{z}$ in (8.39). The condition for $d\hat{W}/\hat{W} > 0$ is given by

$$\frac{m_S}{(1-m_S)(1-\phi)} > \frac{1-\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}{\dfrac{W_U}{W_S-W_U}+\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}. \tag{8.50}$$

Condition (8.50) is less restrictive than (8.48); so if the latter is met, the former will be also.

If the initial value of m_S is high enough to satisfy condition (8.48), the entire path of W_t will be above the initial steady-state values, the sign of the derivative of Ψ_0 will be unambiguously positive, and the participation of skilled labor allocated in the nontradable-good sector z_N will rise. If the initial value of m_S is not high enough to meet condition (8.50), the path of W_t will be below the initial equilibrium values for all $t \in [0,\infty]$, and the derivative of the integral (8.40) will be unambiguously negative. In this case, participation of the nontraded good in the allocation of skilled labor will decrease despite the increase in z. If m_S satisfies condition (8.50) but not (8.48), the path of W_t will be below the initial equilibrium values for some interval $t \in [0,T]$ with T finite, and above the values when $t \in [T,\infty]$. In this case, the sign of the derivative of Ψ_0 will be ambiguous, and the same will happen with z_N.

Another question is also raised. Assuming that m_S satisfies the condition for an increase in Ψ_0 and z_N, one wonders if the rate of change in z_N is higher, equal to, or lower than z, since the result will affect the relative allocation of skilled workers among the nontraded- and exportable-goods sectors. Again, the condition for a rate of change of W_0 higher than $\hat{z}$ is, using the result in (8.39),

$$\frac{m_S(1-\phi)-\phi}{(1-m_S)(1-\phi)} > \frac{1-\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}{\dfrac{W_U}{W_S-W_U}+\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}. \tag{8.51}$$

This condition requires much larger values of m_S to be satisfied than in (8.48). If this condition is met,

$$\frac{dW_0}{W_0} > \hat{z}$$

on impact; and as W_t continues growing for $t \in (0,\infty]$, the rate of growth of Ψ_0 and of z_N will exceed $\hat{z}$, promoting a reallocation of skilled workers toward the nontraded-good sector.

Consider finally the condition to be met to allow for

$$\frac{d\tilde{W}}{\tilde{W}} > \hat{z}.$$

Proceeding in an analogous form to previously, we obtain the following:

$$\frac{m_S - \phi}{(1-m_S)(1-\phi)} > \frac{1-\gamma\dfrac{1-\alpha-\beta}{1-\alpha}}{\dfrac{W_U}{W_S - W_U} + \gamma\dfrac{1-\alpha-\beta}{1-\alpha}}. \tag{8.52}$$

As can be easily seen, (8.52) is less restrictive than (8.51), but not (8.48). If this condition is satisfied, the values of W_t in the new steady state will show an increment with respect to the initial steady state of $\hat{z}$ or more. But since the path for W_t has lower rates of growth than $\hat{z}$ during some interval in the transition, it is not certain that Ψ_0 and z_N will grow more than $\hat{z}$ between the new and the old steady state.

Given reasonable values for the parameters involved, conditions (8.51) and (8.52) are unlikely to be met, but values for m_S that satisfy (8.50) and even (8.48) fall into reasonable ranges. Then, it will be assumed that $0 < \hat{z}_N < \hat{z}$. This implies that $\hat{z}_X$, the rate of change of the participation of skilled workers in the exportable-good sector with respect to the total labor force, is higher than $\hat{z}$.

Since a closed-form solution to the rate of change of z_N cannot be derived, the following representation will be adopted to simplify the calculations:

$$\hat{z}_X = \hat{z} + \theta_X > 0, \tag{8.53a}$$

$$\hat{z}_N = \hat{z} - \theta_N > 0, \tag{8.53b}$$
$$\theta_N, \theta_X > 0.$$

Changes in Physical Capital

The effects of trade policy on physical capital demand and its allocation among the tradable goods can be derived differentiating equations (8.32a) and (8.32b). Using the results in (8.35) and (8.53) the following relations are obtained:

$$\hat{k}_X = \hat{z} + \theta_X + \frac{1}{1-\gamma}\frac{1-\alpha-\beta}{1-\alpha}\left(\hat{P}_X - \hat{P}_M\right) > 0, \tag{8.54a}$$

$$\hat{k}_M = -\frac{z}{1-z}\hat{z} - \frac{1}{1-\gamma}\frac{\beta}{1-\alpha}\left(\hat{P}_X - \hat{P}_M\right) < 0. \tag{8.54b}$$

To obtain the change in aggregate physical capital, $k = k_X + k_M$, we obtain the following relation:

$$\hat{k} = \frac{k_X}{k}\hat{k}_X + \frac{k_M}{k}\hat{k}_M = \frac{k_X}{k}\left(\hat{k}_X - \hat{k}_M\right) + \hat{k}_M. \tag{8.55}$$

Using (8.54a) and (8.54b), $\hat{k}$ is given by

$$\hat{k} = \left(\frac{k_X}{k} - z\right)\frac{\hat{z}}{1-z} + \left(\frac{k_X}{k} - \frac{\beta}{1-\alpha}\right)\frac{\hat{P}_X - \hat{P}_M}{1-\gamma} + \frac{k_X}{k}\theta_X. \tag{8.56}$$

As equations (8.54a–b) show, physical capital is expanding in the exportable-good sector and is contracting in the importable-good sector. The net effect is positive if the exportable-good sector is capital intensive, and its demand of capital in terms of total physical capital has been higher than the participation of skilled workers over the total labor force, and higher than the participation of the exportable good in the product of tradables.

Sectoral and Aggregate Growth

Differentiating the sectoral outputs in equations (8.22a–c), using the results obtained previously on factor demands, gives the following:

$$\hat{y}_N = \hat{z}_N = \hat{z} - \theta_N > 0, \tag{8.57a}$$

$$\hat{y}_X = \gamma \hat{k}_X + (1-\gamma)(\hat{z} + \theta_X) > 0, \tag{8.57b}$$

$$\hat{y}_M = \gamma \hat{k}_M - (1-\gamma)\frac{z}{1-z}\hat{z} < 0, \tag{8.57c}$$

where $\hat{y}_i, i = N, X, M$, is $\hat{y}_i = \frac{dy_i}{y_i}$; and $y_i,\ i = N, X, M$, is $y_i = \frac{Y_i}{L}$.

To find an expression for the aggregate product in this economy, weighting factors must be determined to assemble the rates of changes in sectoral products. Initially it is assumed that not only is the trade balance in equilibrium, but all sectoral outputs equal their respective demand, as in a closed economy. This permits equalized sectoral participations in aggregate product with the same parameters of consumption.

Total demand for the exportable good is given by using (8.20b) and the assumptions made about the origin of expenses in physical and human capital:

$$P_X C_X + \frac{\beta}{1-\alpha} I_K + \beta I_Z = \alpha(E + I_Z). \tag{8.58}$$

The assumption that the trade balance is in equilibrium implies that

$$YN = E + I_K + I_Z, \tag{8.59}$$

where *YN* is the nominal aggregate product. Define the initial investment ratios as

$$\kappa_\kappa = \frac{I_K}{YN}, \tag{8.60a}$$

and let

$$\Lambda_X = \beta\left(1 + \frac{\alpha}{1-\alpha}\kappa_K\right). \tag{8.60b}$$

The aggregate demand for the exportable good is

$$P_X C_X + \frac{\beta}{1-\alpha} I_K + \beta I_Z = \Lambda_X YN. \tag{8.61a}$$

Proceeding in analogous form in the importable sector, we get

$$P_M C_M + \frac{1-\alpha-\beta}{1-\alpha} I_K + (1-\alpha-\beta) I_Z = \Lambda_M YN, \tag{8.61b}$$

where $\Lambda_M = (1-\alpha-\beta)\left(1 + \frac{\alpha}{1-\alpha}\kappa_K\right)$. Finally, total demand for the non-traded good is

$$P_N C_N + \alpha I_Z = (1 - \Lambda_X - \Lambda_M) YN. \tag{8.61c}$$

Equilibrium in the three markets (which implies no trade at the initial equilibrium) requires that the value of production must be equal to total expenditure in each type of good. Given equations (8.61a–c), the conditions for equilibrium are

$$P_X Y_X = \Lambda_X YN, \tag{8.62a}$$

$$P_M Y_M = \Lambda_M YN, \tag{8.62b}$$

$$P_N Y_N = (1 - \Lambda_X - \Lambda_M) YN. \tag{8.62c}$$

From the equilibrium equations (8.62a–c), expressing all the product variables in per capita terms (dividing all magnitudes by total labor force L), the implicit price indexes for the different products are obtained: where

$$yn = \frac{YN}{L},$$

then

$$P_X = \Lambda_X \frac{yn}{y_X}, \tag{8.63a}$$

$$P_M = \Lambda_M \frac{yn}{y_M}, \tag{8.63b}$$

$$P_N = \left(1 - \Lambda_X - \Lambda_M\right) \frac{yn}{y_N}. \tag{8.63c}$$

Define the "real" aggregate product as the nominal product divided by the aggregate perfect price index $P = P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}$, that is,

$$Y = \frac{YN}{P} = \frac{YN}{P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}}, \tag{8.64a}$$

or in per capita terms,

$$y = \frac{yn}{P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}}. \tag{8.64b}$$

Substituting the price indexes (8.63a–c) in (8.64b), the following expression for the aggregate "real" product results:

$$y = \frac{yn}{\left[\left(1 - \Lambda_X - \Lambda_M\right) \frac{yn}{y_N}\right]^{\alpha} \left(\Lambda_X \frac{yn}{y_X}\right)^{\beta} \left(\Lambda_X \frac{yn}{y_M}\right)^{1-\alpha-\beta}} \tag{8.65}$$

$$= \frac{y_N^{\alpha} y_X^{\beta} y_M^{1-\alpha-\beta}}{\left(1 - \Lambda_X - \Lambda_M\right)^{\alpha} \Lambda_X^{\beta} \Lambda_M^{1-\alpha-\beta}}.$$

Totally differentiating equation (8.65), the rate of growth of aggregate product is given by

$$\hat{y} = \alpha\hat{y}_N + \beta\hat{y}_X + (1-\alpha-\beta)\hat{y}_M. \qquad (8.66)$$

Substituting equations (8.57a–c) in (8.66) and using the expressions for factor accumulation in (8.39) and (8.54a–b), an expression for the growth rate of this economy is found:

$$\hat{y} = \frac{\phi}{1-\phi}\left(\frac{\alpha+\beta}{z}-1\right)\frac{z}{1-z}\frac{dW_S - dW_U}{W_S - W_U} - \alpha\theta_N + \beta\theta_X. \qquad (8.67)$$

Ignoring the effect of the term $-\alpha\theta_N + \beta\theta_X$, which measures the impact on aggregate growth of the change in the allocation of skilled labor for the nontraded and the exportable good, the change in trade policy analyzed in this section will have a positive impact on aggregate output if the participation of the sectors that use skilled labor (nontraded and exportable, given by $\alpha + \beta$) is high with respect to the ratio of skilled labor to the total labor force.

It can be seen from equations (8.54a–b) that two effects impact the allocation of physical capital among sectors. One is the "equilibrium capital-labor ratio" effect, which drives the demand for physical capital via changes in labor use. The other is a substitution effect that modifies that capital labor ratio via changes in relative prices. This substitution effect increases the demand for physical capital in the exportable sector and reduces it in the importable sector. In the derivation of equation (8.67), those movements are compensated for, because the assumptions made about the relative participations of all sectors in output imply that the incidence in aggregate growth of expansion in the exportable sector due to higher demand for physical capital (sparked in turn by a change in relative prices) is exactly matched by the incidence of contraction in the importable sector due to analogous reasons.

Consequently, the only effect that influences aggregate growth is the change in labor composition. As a higher percentage of the total labor force is skilled, output of the nontraded and the exportable good will expand while output of the importable good contracts. The net effect is an increment in aggregate output if the incidence of the sectors that are increasing production, $\alpha+\beta$, is high enough to overcome reduced production of the importable good.

The condition $\frac{\alpha+\beta}{z}>1$ for positive aggregate output growth implies that the participation of sectors that are expanding in total output is higher than the participation of their labor resource inputs from the total labor force. This is consistent with the conclusion that can be drawn from (8.33), that is, the relative higher capital intensity of the exportable compared to the importable good.

Estimation

Implementation of the System

The model to be estimated is the production function (8.65), after substituting for the sectoral outputs the production functions (8.22a–c) and the dynamic equations for z and k, (8.39) and (8.56). Beginning from the production function, the following is obtained:

$$y=\frac{A_N^{\alpha}A_X^{\beta}A_M^{1-\alpha-\beta}}{\left(1-\Lambda_X-\Lambda_M\right)^{\alpha}\Lambda_X^{\beta}\Lambda_M^{1-\alpha-\beta}}\left[\left(\frac{z_n}{z}\right)^{\alpha}\left(1-\frac{z_n}{z}\right)^{\gamma\beta}\right] \times z^{\alpha+\beta\gamma}\left(1-z\right)^{\gamma(1-\alpha-\beta)}k_X^{(1-\gamma)\beta}k_M^{(1-\gamma)(1-\alpha-\beta)}. \tag{8.68}$$

The weighted average of the skilled and unskilled labor in various sectors is expressed by

$$\left[\left(\frac{z_n}{z}\right)^{\alpha}\left(1-\frac{z_n}{z}\right)^{\gamma\beta}\right]z^{\alpha+\beta\gamma}\left(1-z\right)^{\gamma(1-\alpha-\beta)}.$$

Assuming the initial participations as given, as well as the investment ratios in Λ_X, Λ_M, the production function can be presented in an estimable form as

$$y = M h^{1-\sigma} k^{\sigma}$$

$$M = \frac{A_N^{\alpha} A_X^{\beta} A_M^{1-\alpha-\beta}}{\left(1-\Lambda_X-\Lambda_M\right)^{\alpha} \Lambda_X^{\beta} \Lambda_M^{1-\alpha-\beta}} \left[\left(\frac{z_n}{z}\right)^{\alpha} \left(1-\frac{z_n}{z}\right)^{\gamma\beta} \right]$$

$$h^{1-\sigma} = z^{\alpha+\beta\gamma} \left(1-z\right)^{\gamma\left(1-\alpha-\beta\right)} \tag{8.69}$$

$$k^{\sigma} = k_X^{\left(1-\gamma\right)\beta} k_M^{\left(1-\gamma\right)\left(1-\alpha-\beta\right)}$$

$$\sigma = \left(1-\alpha\right)\left(1-\gamma\right),$$

where h is an index of skilled to unskilled workers and M will be assumed constant. Finally, in logarithmic form,

$$\ln y_t = \ln M + \left(1-\sigma\right) \ln h_t + \sigma \ln k_t . \tag{8.70}$$

To transform this equation into a dynamic version, one must take into account, as analysis earlier in the chapter revealed, that TFP, which is the residual of an expression like (8.70), is stationary. But since the aggregate output, the index of human capital, and all measures of physical capital are nonstationary, there must be a cointegration relationship in (8.70) that transforms variables $I(1)$ into $I(0)$. We will interpret the cointegration relation precisely as the production function.

But if a cointegration relationship exists between y, h, and k, the dynamic version of (8.70) is not just its first differences. Suppose the following partial adjustment mechanism for the equilibrium relationship (8.70), where the constant term is dropped for simplicity:

$$\ln y_t = a \ln y_{t-1} + b_0 \ln h_t + b_1 \ln h_{t-1} + c_0 \ln k_t + c_1 \ln k_{t-1} . \tag{8.71}$$

Deducing $\ln y_{t-1}$ from each side and making the appropriate adjustments in the other variables, we obtain:

$$\Delta \ln y_t = b_0 \Delta \ln h_t + c_0 \Delta \ln k_t - (1-a)\left(\ln y_{t-1} - \frac{b_0 + b_1}{1-a} \ln h_{t-1} - \frac{c_0 + c_1}{1-a} \ln k_{t-1} \right). \tag{8.72}$$

The term in brackets on the right-hand side is the residual of a regression of $\ln y$ on the factors of production, that is, the lagged-once residual of the production function.

To conclude, the estimable version of equation (8.70) is

$$\Delta \ln y_t = b_0 \Delta \ln h_t + c_0 \Delta \ln k_t - (1-a)\left(\ln y_{t-1} - (1-\sigma) \ln h_{t-1} - \sigma \ln k_{t-1} \right) + u_t. \tag{8.73}$$

Since a linear relationship between the rates of growth of z and h can be obtained from (8.69), equation (8.39) can be expressed as

$$\Delta \ln h_t = d_1 \Delta \ln h_{t-1} + e_0 \Omega_t + v_t, \tag{8.74}$$

where Ω_t represents exogenous variables that drive the dynamics of h. These variables may well include the error-correction mechanism in (8.73). Finally, the estimable version of (8.56) is

$$\Delta \ln k_t = f_1 \Delta \ln k_{t-1} + g_0 \Delta \ln h_t + g_1 \Delta \ln h_{t-1} + m_0 \Phi_t + w_t, \tag{8.75}$$

where Φ_t represents exogenous variables that determine k. The system (8.73–75) permits one to estimate z, h and k simultaneously. To avoid problems of simultaneity bias, an instrumental variable (IV) estimation procedure was implemented.

Instrumental Variable Estimation

In the first stage, the production function (8.70) was estimated in levels to test for the stationariness of its residuals and the appropriateness of the error correction mechanism in (8.73). The dependent variable is the GDP per capita (in logs, LPBIPC). Besides the index of human capital

Table 8.4. Dependent Variable: GDP Per Capita
(in logs)

Dependent variable LPBIPC
Estimation by least squares
Annual data from 1956:01 to 1999:01
Usable observations: 44

R^2	0.86
Mean of dependent variable	3.46
Std. error of dependent variable	0.15
Std. error of estimate	0.06
Sum of squared residuals	0.15
Durbin-Watson statistic	0.53
Q(11-0)	50.82
Significance level of *Q*	0.00

Variable	Coeff.	Std. error	*t*-stat.
1. Constant	–0.672	0.11	–5.98
2. LICAPHUM	0.550	0.08	6.88
3. LCAPPRFIJPC	0.271	0.05	5.51
4. LCONSTPUBPC	0.178	0.06	3.09

(LICAPHUM) and private sector fixed capital (LCAPPRFIJPC) as explanatory variables, public sector infrastructure (LCONSTPUBPC) was also included in the production function as a predetermined variable. The equation was estimated subject to the restriction that the sum of the parameters had to add up to one.

To estimate the system (8.73–75) a policy variable must be defined to get the impact of trade policy changes on the dynamics of factor accumulation and growth. The openness ratio shown in Figure 8.6 cannot be used as a proxy for the commercial policy since it may be endogenous to the variables that must be determined, such as human and physical capital accumulation. An index of commercial policy therefore was defined by two steps: (1) regressing the openness ratio (GRADAP) on the index of nominal protection presented in Figure 8.9 (LPROTEC), a dummy for the Mercosur period (DUMMERC), and the real exchange rate (LURUTCR), and (2) combining the index of nominal protection and the Mercosur dummy using the coefficients obtained in the first step to construct a com-

Table 8.5. Dependent Variable: Openness Ratio

Dependent variable GRADAP
Estimation by least squares
Annual data from 1956:01 to 1999:01
Usable observations: 44

R^2	0.95
Mean of dependent variable	0.39
Std. error of dependent variable	0.14
Std. error of estimate	0.03
Sum of squared residuals	0.04
Regression $F(3,40)$	257.91
Significance level of F	0.00
Durbin-Watson statistic	1.16
$Q(11\text{-}0)$	24.71
Significance level of Q	0.01

Variable	**Coeff.**	**Std. error**	***t*-stat.**
1. Constant	1.086	0.08	13.17
2. DUMMERC	0.198	0.02	10.16
3. LPROTEC	–0.086	0.01	–10.57
4. LURUTCR	–0.048	0.02	–3.15

mercial policy index. The regression obtained in the first step is shown in Table 8.5.

The presence of a unit root in the residuals of this equation is rejected. The index of commercial policy is then defined as

$$\text{COMPOL} = 1.085910342 + 0.197609409{*}\text{DUMMERC} - 0.086494762{*}\text{LPROTEC}. \qquad (8.76)$$

The system (8.73–75) was estimated using IV. The variable RESPBI represents the residuals of the production function in levels. The equation for the change in the product per capita is shown in Table 8.6.

The equation for the change in private fixed capital is shown in Table 8.7. As can be seen, this variable is also exogenous with respect to the other dependent variables, human capital, and growth. It is interesting to note the significance of public sector construction as an explanatory variable for the dynamics of private sector investment.

Table 8.6. Dependent Variable: Change in GDP Per Capita

Dependent variable DLPBIPC
Estimation by instrumental variables
Annual data from 1960:01 to 1999:01
Usable observations: 40

R^2	0.71
Mean of dependent variable	0.01
Std. error of dependent variable	0.04
Std. error of estimate	0.03
Sum of squared residuals	0.02
Durbin-Watson statistic	1.96
Q(10-0)	6.29
Significance level of *Q*	0.79

Variable	**Coeff.**	**Std. error**	***t*-stat.**
1. Constant	–0.009	0.01	–1.33
2. RESPBI {1}	–0.475	0.10	–4.73
3. DLPBIPC {1}	0.722	0.14	5.27
4. DLICAPHUM	–0.313	0.15	–2.06
5. DLICAPHUM {2}	0.398	0.16	2.52
6. DLCAPPRFIJPC	0.842	0.14	5.90
7. DLCAPPRFIJPC {1}	–1.107	0.28	–3.99
8. DLCONSTPUBPC {1}	0.778	0.24	3.20
9. DLCONSTPUBPC {2}	0.175	0.12	1.45
10. DLCONSTPUBPC {3}	–0.211	0.12	1.79

As suggested by the model, the stylized facts, and the unit root tests discussed previously, both the introduction of Mercosur and Uruguay's unilateral liberalization efforts may have influenced the evolution of human capital. Thus the commercial policy variable (in differences, DCOMPOL) was introduced as an explanatory variable for the increment in human capital, together with other contemporary and lagged endogenous variables of the system. The equation for the change in human capital is shown in Table 8.8.

Table 8.7. Dependent Variable: Private Fixed Capital

Dependent variable DLCAPPRFIJPC
Estimation by instrumental variables
Annual data from 1960:01 to 1999:01
Usable observations: 40

R^2	0.88
Mean of dependent variable	0.00
Std. error of dependent variable	0.04
Std. error of estimate	0.01
Sum of squared residuals	0.01
Durbin-Watson statistic	1.95
Q(10-0)	7.89
Significance level of *Q*	0.64

Variable	Coeff.	Std. error	*t*-stat.
1. Constant	–0.002	0.01	–0.94
2. DLCAPPRFIJPC {1}	0.689	0.12	5.53
3. DLCONSTPUBPC	0.878	0.05	16.58
4. DLCONSTPUBPC {1}	–0.683	0.11	–6.24

Table 8.8. Dependent Variable: Change in Human Capital Index

Dependent variable DLICAPHUM
Estimation by instrumental variables
Annual data from 1960:01 to 1999:01
Usable observations: 40

R^2	0.75
Mean of dependent variable	0.02
Std. error of dependent variable	0.03
Std. error of estimate	0.02
Sum of squared residuals	0.01
Durbin-Watson statistic	1.88
Q(10-0)	8.92
Significance level of *Q*	0.54

Variable	Coeff.	Std. error	*t*-stat.
1. Constant	0.013	0.01	2.30
2. DLPBIPC	–0.333	0.22	–1.52
3. DLPBIPC {1}	0.279	0.15	1.88
4. DLPBIPC {2}	–0.369	0.13	–2.82
5. DLPBIPC {3}	0.317	0.13	2.43
6. DLICAPHUM {1}	–0.168	0.17	–0.95

(*continued on next page*)

Table 8.8 *(continued)*

7. DLICAPHUM {2}	0.354	0.19	1.82
8. DLICAPPRFIJPC	0.603	0.27	2.25
9. DLICAPPRFIJPC {1}	–0.364	0.16	–2.27
10. DLICAPPRFIJPC {2}	0.387	0.14	2.82
11. DLICAPPRFIJPC {3}	–0.531	0.13	–4.09
12. DLCONSTPUBPC	–0.336	0.26	–1.29
13. DCOMPOL	0.417	0.12	3.38
14. DCOMPOL {1}	0.020	0.14	0.14
15. DCOMPOL {2}	0.523	0.13	3.91
16. DCOMPOL {3}	–0.199	0.15	–1.29

Figure 8.11a. Log of GDP Per Capita

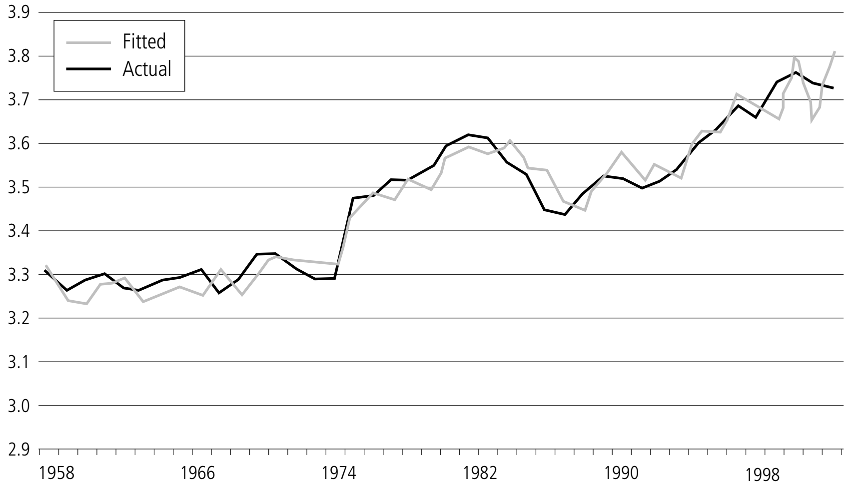


Figure 8.11b. Log of Human Capital Index

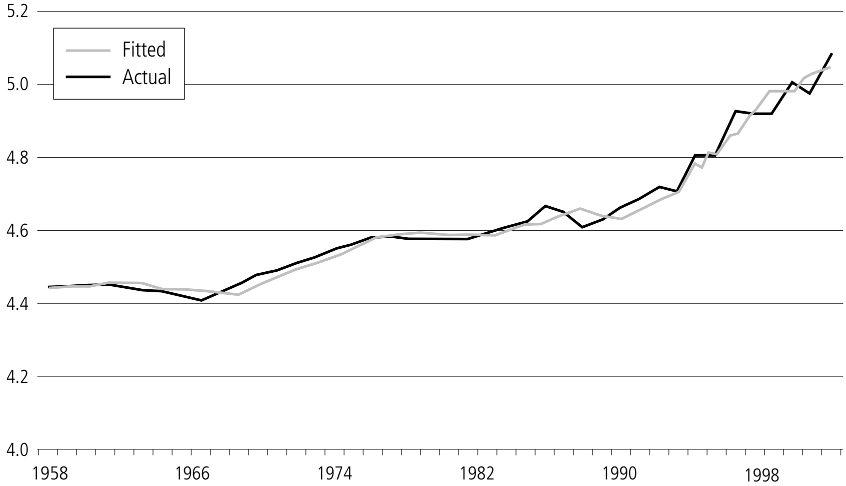
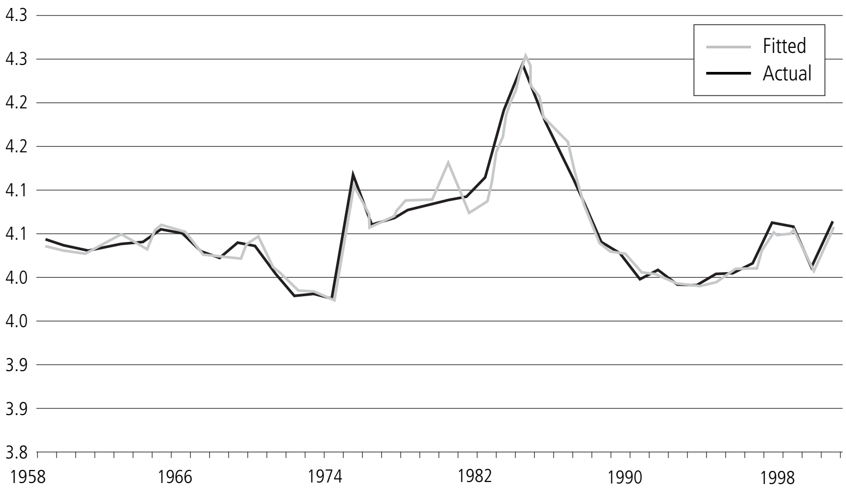


Figure 8.11c. Log of Private Fixed Capital



Conclusions

This chapter studied the dynamics of economic growth in Uruguay during the last five decades. The most relevant empirical regularities to be explained are:

- The actual acceleration of economic growth, measured as the rate of variation of GDP per capita, after the economic reforms toward a market-oriented economy began to be implemented;
- The high contribution of human capital accumulation to the growth of GDP per worker over the entire period under consideration, but especially in the decade of the 1990s;
- The absence of change in TFP, which most of the time was actually negative according to growth accounting calculations; and
- The stability of net investment in physical capital before and after implementation of the reforms, notwithstanding some periods of temporary acceleration.

A model that explains most of these facts was formulated, and an estimation of its empirical consequences was performed. Essentially the behavior of the Uruguayan economy fits into the characteristics of a neoclassical model of economic growth, in which policy changes have transitory impacts on investment and growth until the economy reaches a new steady state with higher output per capita but the same prior equilibrium rate.

The model suggests that policy changes did help develop sectors in which use of skilled labor was relatively intensive. According to the model (and this is confirmed by the facts), if the economy receives a shock that favors the relative redistribution of skilled work, then the wage differential will rise, promoting the formation of human capital.

The model predicts a transitory higher growth rate of final output above the initial equilibrium, with the growth rate decreasing as the economy approaches its new steady state, clearly a neoclassical result.

The model estimated, whose structure is derived from the theoretical model formulated, represents quite well the dynamics of growth and factors accumulation during the period under study. One can clearly conclude from the empirical evidence that economic growth in Uruguay has been supported by the accumulation of physical and human capital, with little or no contribution from changes in TFP.

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Part III

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Francisco Rodríguez

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