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GROWTH DIAGNOSTIC: PERU

BY

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Abstract

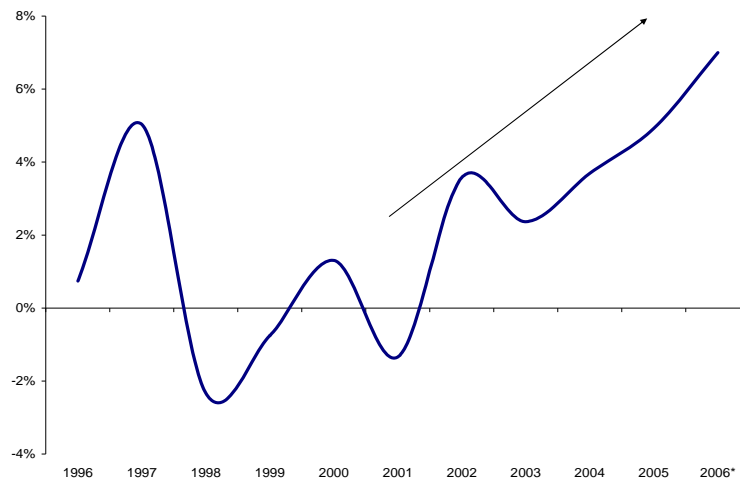
This paper presents a growth diagnostic exercise for Peru. It notes that although Peru has recently enjoyed high rates of economic growth, this growth is actually a recovery from a significant and sustained growth collapse that began in the 1970s. Income per capita has barely recovered to its historical peak, despite significant improvements in education, infrastructure, the financial system, political stability, institutional quality, and macroeconomic sustainability. The growth collapse was caused by a decline in export earnings due to the fall in international prices and an inadequate investment regime in export activities that led to a fall in market share. This situation led to collateral damage in the form of a balance of payments, fiscal, and financial crisis, accompanied by hyperinflation and violence, but these aspects were corrected in the 1990s. However, the transformation of the export sector has been surprisingly small: the same activities that declined – mining and energy – are the ones that are leading the current recovery in exports to levels that in real per capita terms are similar to those achieved 30 years ago. The authors argue that the lack of structural transformation is associated with Peru's position in a poorly connected part of the product space and this accentuates coordination failures in the movement to new activities. In addition, Peru's current export package is very capital intensive and generates few jobs, especially in urban areas where the bulk of the labor force is now located. This limits the welfare benefits of the current growth path. The key policy message is that the public sector must act to encourage the development of new export activities that better utilize the human resources of the country. This involves action on the macro front to achieve a more competitive real exchange rate, improvements in the capacity to solve coordination failures in the provision of specific public sector inputs, and programs to stimulate investment in new tradable activities.

JEL Classifications: E61, F14, O25, O54.

Peru's Growth Story

By many measures, times are good in Peru. During the past two years, Peru has been among Latin America's best performing economies in terms of growth in gross domestic product (GDP), with low inflation and a stable exchange rate. Although poverty rates remain high (more than 50 percent of the population in 2004, using the national poverty line), they have been slowly falling. The country has enjoyed robust economic growth since 2002, and would appear to be in a growth acceleration.

Figure 1. Growth Rate of GDP per Capita in Peru, 1996-2006

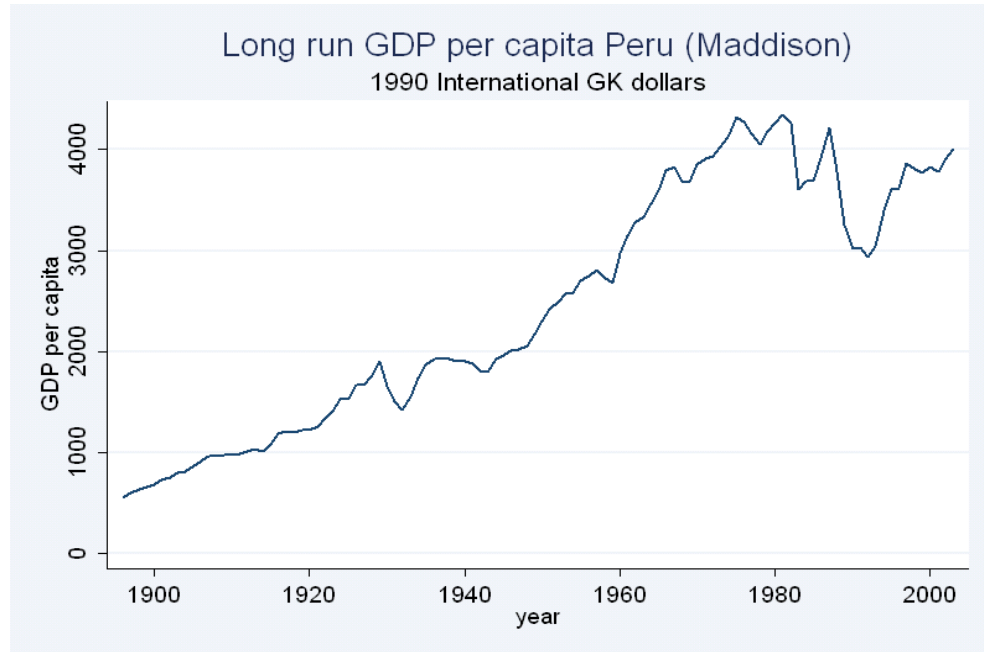


Source: WDI.

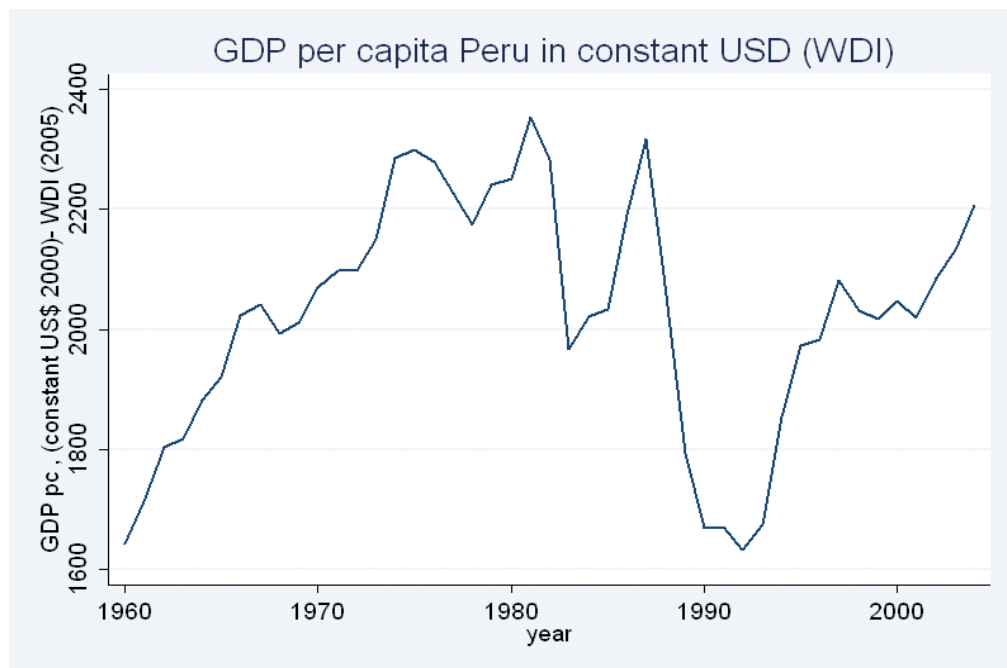
Yet it is important to put this boom in historical perspective. Figures 1 and 2 show GDP per capita in Peru over the entire 20th century, as well as a detailed look from 1960 to 2005. Except for a moderate output collapse and recovery in the 1930s, around the time of the Great Depression, Peru followed a steady upward trend in output per capita until the mid 1970s, when growth stopped and then collapsed in the late 1970s and early 1980s.

Considering Peru's long-term growth history, the current acceleration of growth is actually a recovery from the growth collapse. Importantly, as of 2005, the country had yet to return to its historical peak GDP per capita of 30 years ago, in spite of the fact that global technology has allowed other countries to achieve productivity levels that are substantially higher.

**Figure 2. The Long-term Economic Performance of Peru
1890 - 2004**



1960-2005

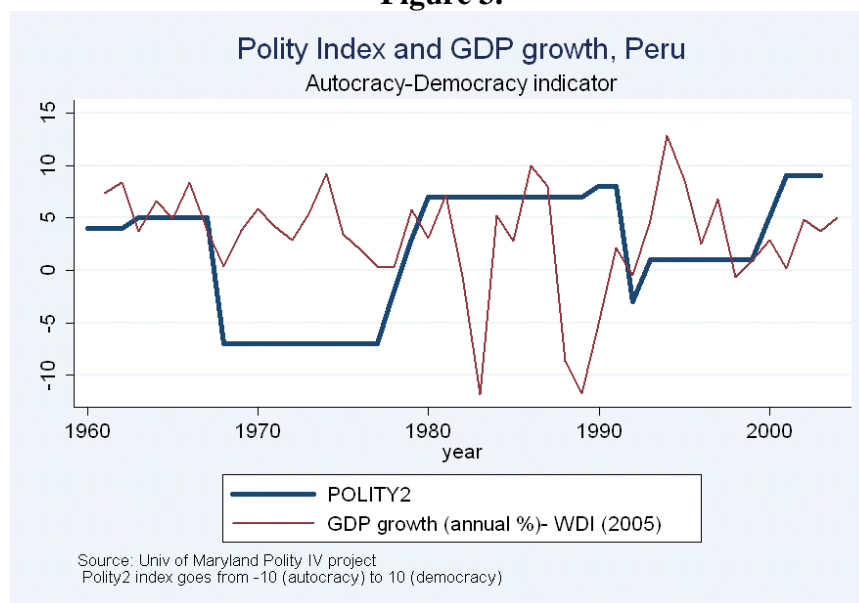


Source: WDI and Maddison. Long-run GDP per capita figures are in Geary-Khamis dollars (see Maddison ,2000). Recent figures from WDI are in 2000 U.S. dollars.

This characterization of Peru's output dynamics is critical for diagnosing the constraints on future economic growth. The country is a clear case of a growth collapse. Moreover, this collapse was drawn-out, and recovery has been slow and as of yet incomplete.

These dynamics allow us to reject many potential explanations for Peru's growth constraints. For example, neither human capital nor physical infrastructure suffered a significant shock in the mid to late 1970s that could have caused the growth collapse. In fact, as we shall see below, if anything, school attainment levels have risen significantly. Moreover, this was not a period of significant political shocks. The growth collapse occurred in the context of a transition to democracy, and the political instability and damage to human and physical capital caused by the rise of the Shining Path guerilla movement occurred after the collapse (Figure 3).

Figure 3.



Note: The POLITY2 index goes from -10 (autocracy) to 10 (democracy).

Source: University of Maryland Polity IV Project.

The growth collapse was accompanied by a balance of payments crisis, an acceleration of inflation, and a debt crisis. Could such macroeconomic issues explain the slow and partial recovery from the deep and protracted growth collapse? Could they constitute the current constraint on growth? Consider an analogy: When a fan belt fails in an automobile, the collateral damage can include the virtual melting of the engine. In this case, the fan belt may be the cause of the car's collapse, but a new fan belt will no longer cure the problem, as damage has spread to other parts of the automobile. Similarly, although Peru's growth collapse may have been caused by something else, and then itself caused macroeconomic instability, that instability could very well be the current binding constraint.

For Peru, this is clearly not the case. Peru has now gone through more than a decade of macroeconomic stability, fiscal consolidation, and external creditworthiness that represents a substantial improvement *vis a vis* the situation 30 years ago when GDP per capita peaked. If macroeconomic instability was the binding constraint on growth, then a prolonged period of dramatic improvements in this area should have allowed a full recovery. After all, there is ample evidence that recoveries from macroeconomic crises tend to be relatively rapid (Calvo, Izquierdo, and Talvi, 2006).

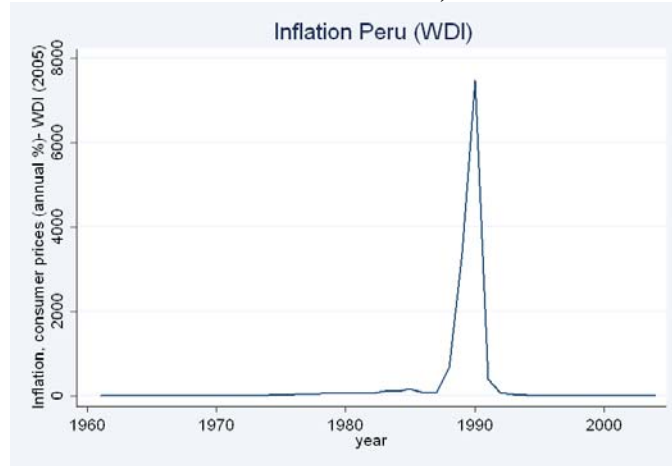
More importantly, the country now has more education, physical infrastructure, and political stability than it had in the late 1970s (see Figures 4 to 7), yet it has still to see a full recovery. As we will argue in greater detail, these are not convincing constraints on economic growth in Peru.

Figure 4.
Current Account over Time, Peru



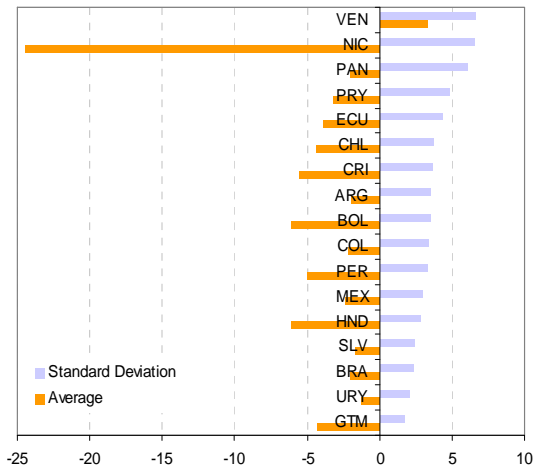
Source: WDI (2005).

Figure 5.
Inflation over Time, Peru

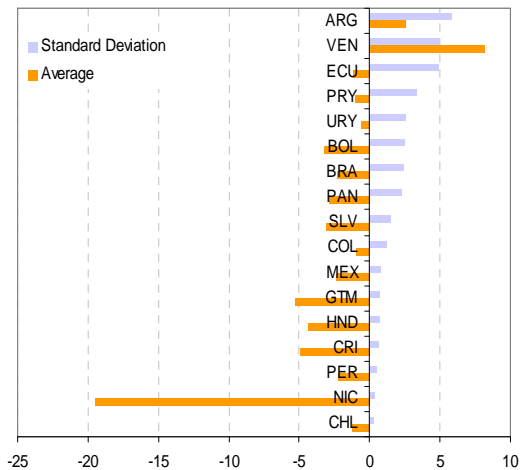


Source: WDI (2005).

Figure 6.
Current Account/GDP - Average and Standard Deviation Latin America (1980-2003)

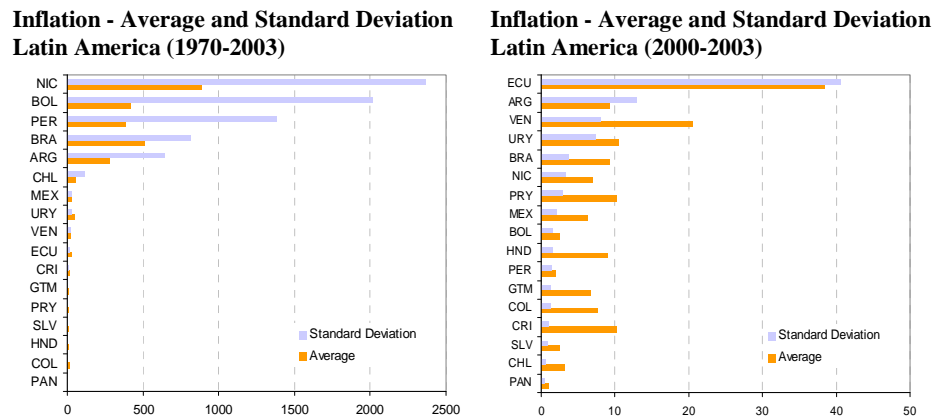


Current Account/GDP - Average and Standard Deviation Latin America (2000-2003)



Source: WDI (2005)

Figure 7.

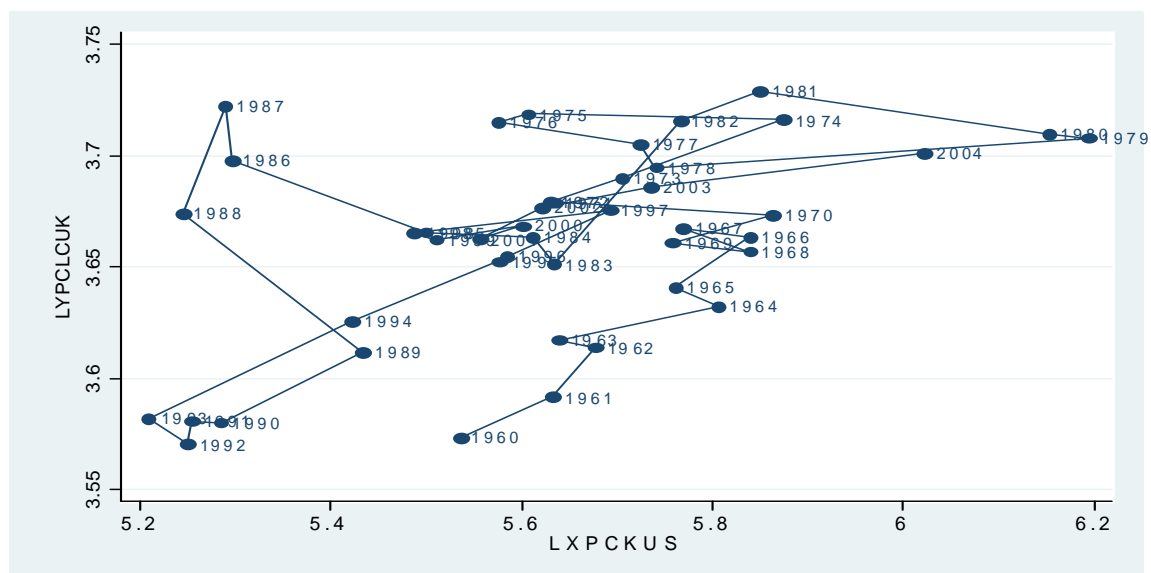


Source: WDI (2005)

Note: Figure 7 is adapted from Cubillos et al. (2005).

A much more convincing explanation can be found in a careful examination of Peru's export dynamics. Figure 8 shows the evolution of exports per capita on the x-axis, and GDP per capita on the y-axis. The figure shows two significant export collapses, the first starting after 1979 and the second after 1984. These export collapses preceded two periods of sharp output decline. Peru's post-1980s woes were brought about by an export collapse, which then led to balance of payments problems and financial crises.

Figure 8. The Evolution of Output and Exports per Capita

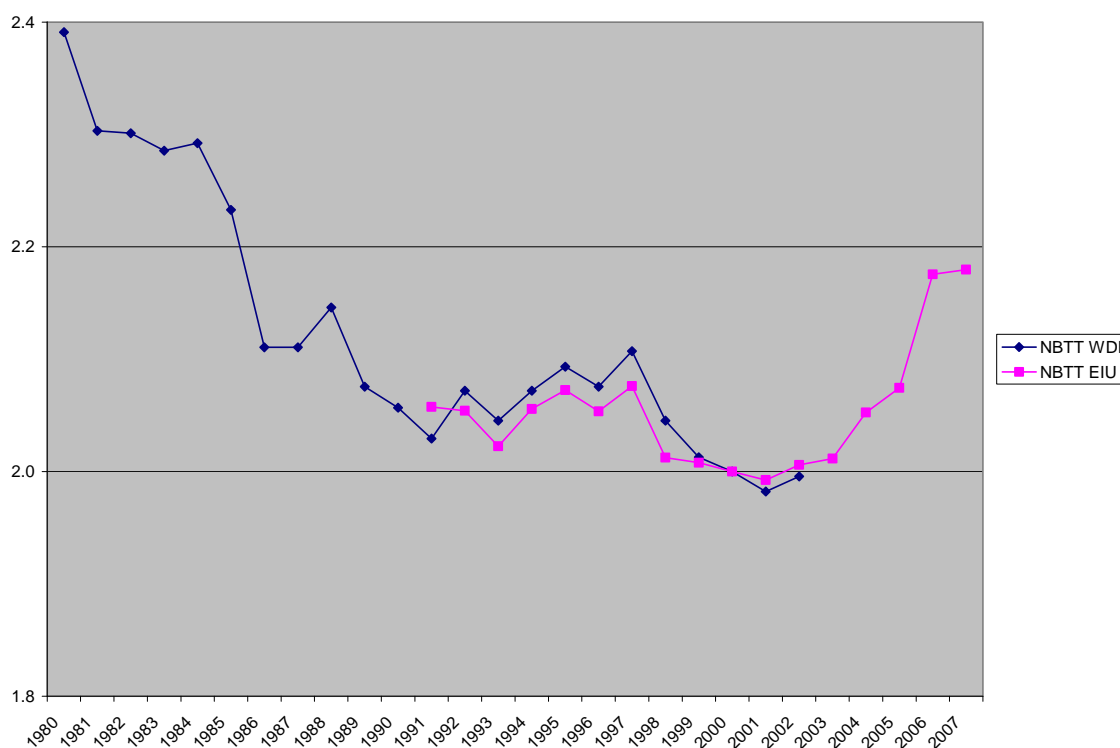


Source: WDI.

The export collapse was quite significant. From 1979 to 1983, exports per capita fell by 40 percent, and from 1979 to 1993, by more than 80 percent. In 1985, the government attempted to recover output through an expansion of domestic demand. However, this was accompanied by falling exports and the situation became externally unsustainable in 1987, which led to a very large collapse in output during the following three years.

What caused the export collapse? It was first and foremost a terms of trade shock. Exogenous shocks to international prices in Peru's primary export sectors, notably mining and plantation agriculture, caused a steep decline in export incomes, which then led to an output collapse and significant collateral damage to the political and financial systems. Figure 9 shows Peru's terms of trade and its dramatic collapse after the East Asian crisis. Interestingly, this period can be traced back to the output numbers and corresponds to an "interruption" of Peru's recovery from the growth collapse.

Figure 9. Terms of Trade, 1980-2007 (logs)



Source: WDI and EIU.

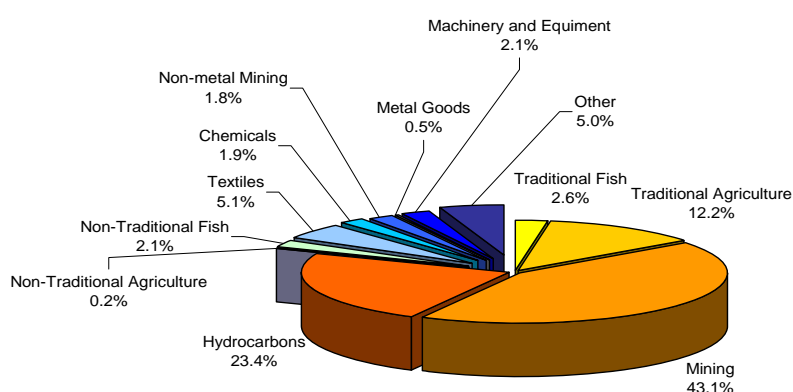
It is clear that output dynamics in Peru are closely linked to the export sector. Moreover, a significant cause of the export collapse was the terms of trade shocks the country suffered in the late 1970s and early 1980s. Since the early 1990s, the macroeconomic, financial, and political situations, which were somewhat chaotic after the export collapse, have significantly improved. Moreover, since 2004, the terms of trade have recovered to levels not seen since the early 1980s. Yet Peru is barely back to its historical levels of output per capita, and relative to the rest of the world, it is well below its position in the late 1970s. True, the terms of trade are not back to the levels of the late 1970s, but over the course of almost three decades the country could have moved to other more attractive products.

Our diagnosis of this situation is that in the face of a terms of trade shock, there was no structural transformation in Peru. This was despite decades when relative prices, in terms of a much more depreciated real exchange rate and lower prices for traditional exports, favored the movement to new export sectors. The country was not able to discover new export activities to compensate for those that faced international headwinds. Instead, Peru simply sat in a collapse until international prices in mining and fuels improved.

This can be seen clearly in the composition of the export basket and how it changed during the growth collapse and recovery. Below we examine two periods: 1979 to 1993 (collapse) and 1993 to 2005 (recovery).

Figure 10.

Decomposing the Export Collapse: 1979-1993



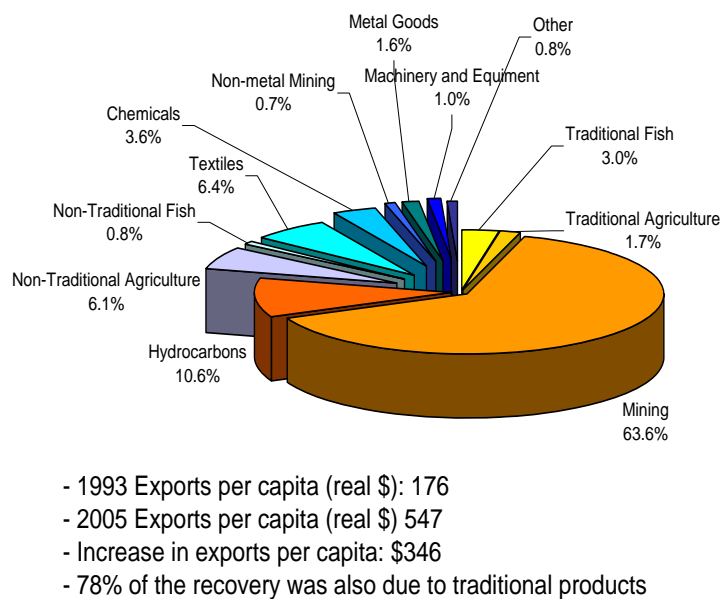
- 1979 Exports per capita (real \$): 522
- 1993 Exports per capita (real \$) 176
- Fall in exports per capita: \$346
- 81% of the fall was due to traditional products

Source: BCRP and INEI.

Figure 10 shows that traditional agriculture, hydrocarbon products, and mining were the export sectors that collapsed to the greatest degree. Figure 11 shows the decomposition of exports for the 1993 to 2005 recovery period. If Peru underwent structural transformation in response to the collapse in its key export sectors, we would expect different sectors to fuel the recovery.

Figure 11.

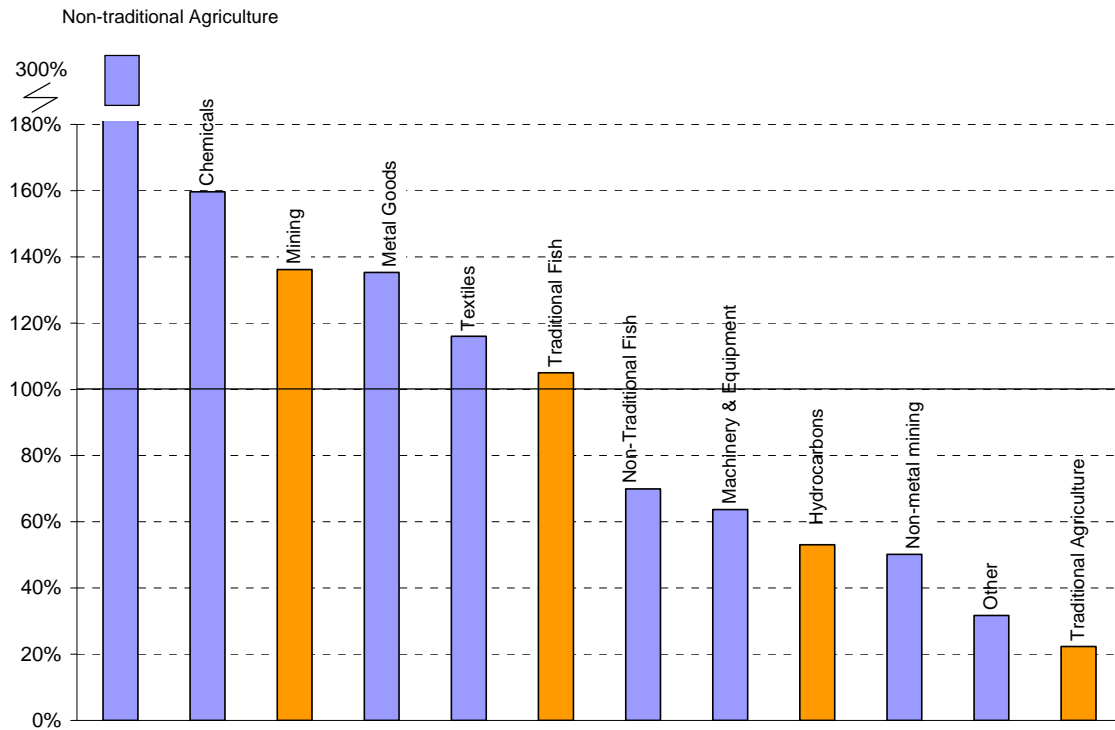
Decomposing the Export Recovery 1993-2005



Source: BCRP and INEI

The sectors that led the recovery in Peruvian exports between 1993 and 2005 were hydrocarbons and mining, followed by traditional agriculture. These are the same sectors that collapsed in the 1970s and 1980s. Peru underwent very little structural transformation in response to its export collapse.

Figure 12.
Exports per Capita by Sector in 2005
(Percentage of levels in 1979)



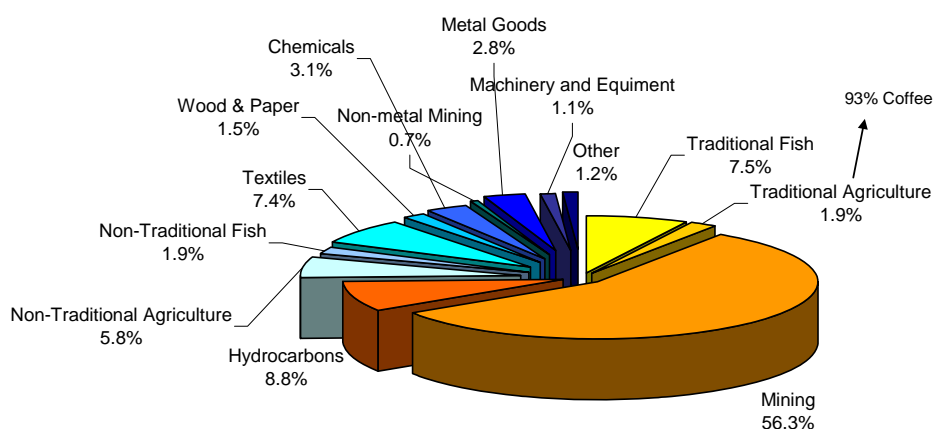
Source: BCRP and INEI.

Of Peru's dominant sectors, traditional agriculture did not recover from the collapse, the hydrocarbon sector has recovered but not completely (although it should do so upon the completion of the Camisea natural gas project), and fishing and mining have now recovered (Figure 12). The same sectors that collapsed have led the recovery, and there was no re-orientation of productive capacities.

The one exception is the emergence of the non-traditional agriculture sector, which is more than three times as large in 2005 as it was in 1979 (in per capita terms). However, Figure 13 shows that the non-traditional agriculture sector was of minor importance in the export recovery post-1993, contributing only 6.1 percent of the export growth. In terms of the overall export basket in 2005, non-traditional agriculture only amounts to 5.8 percent.

This discovery was not nearly enough to affect the macro numbers. Compare this to the case of Mexico or Indonesia, where a slew of new sectors were discovered that more than offset the negative effects of the decline in oil prices. Peru's dominant export sectors continue to be mining and hydrocarbons, despite the incentives for discovery created by the terms of trade shock and the subsequent real depreciation.

Figure 13.
The Composition of Peru's Exports, 2005
Exports, 2005

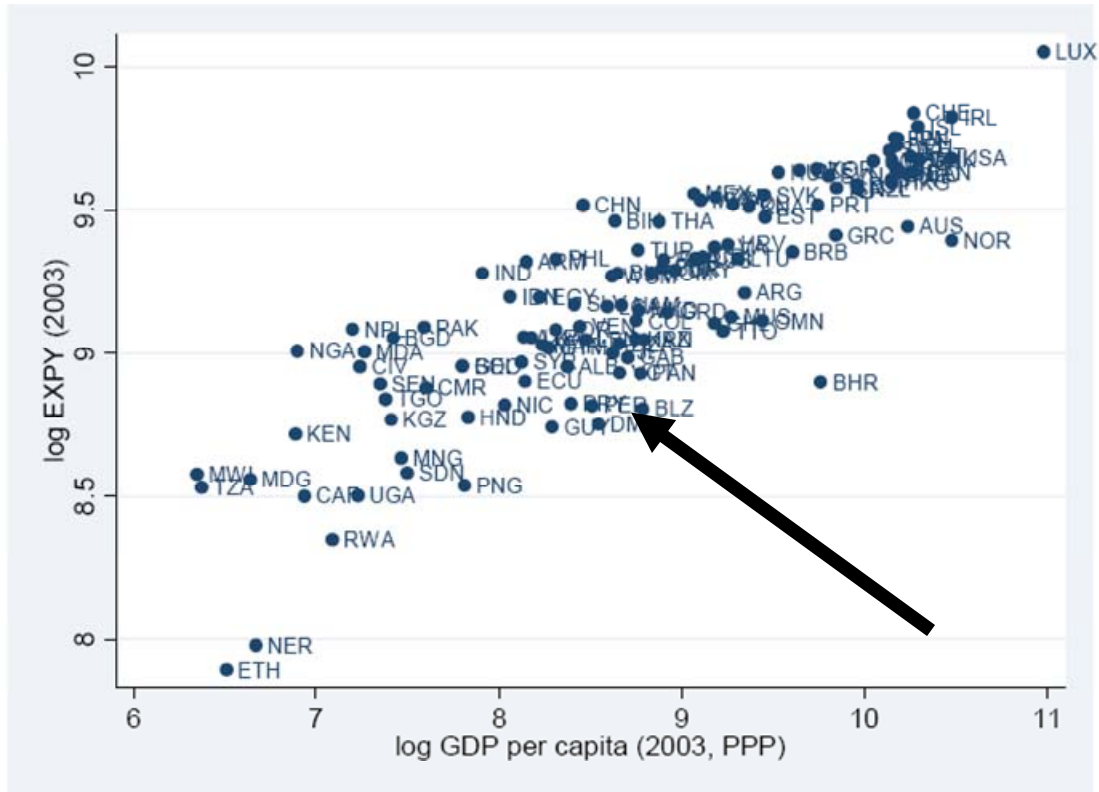


Source: BCRP and INEI.

The lack of new export sectors appearing in Peru's aggregate production function is therefore a key constraint to growth. We argue that this is in part due to the nature of Peru's specialization. First, consider the country's export sophistication, which has been shown elsewhere as a key driver of growth (Hausmann Hwang, and Rodrik 2006). This is measured simply as the GDP per capita of countries with a similar export package, called EXPY (see the Appendix for technical details). Figure 14 shows actual income levels and the sophistication of the export basket (EXPY) for a cross-section of countries.

Figure 14.

Figure 4: Relationship between per-capita GDP and *EXPY*, 2003

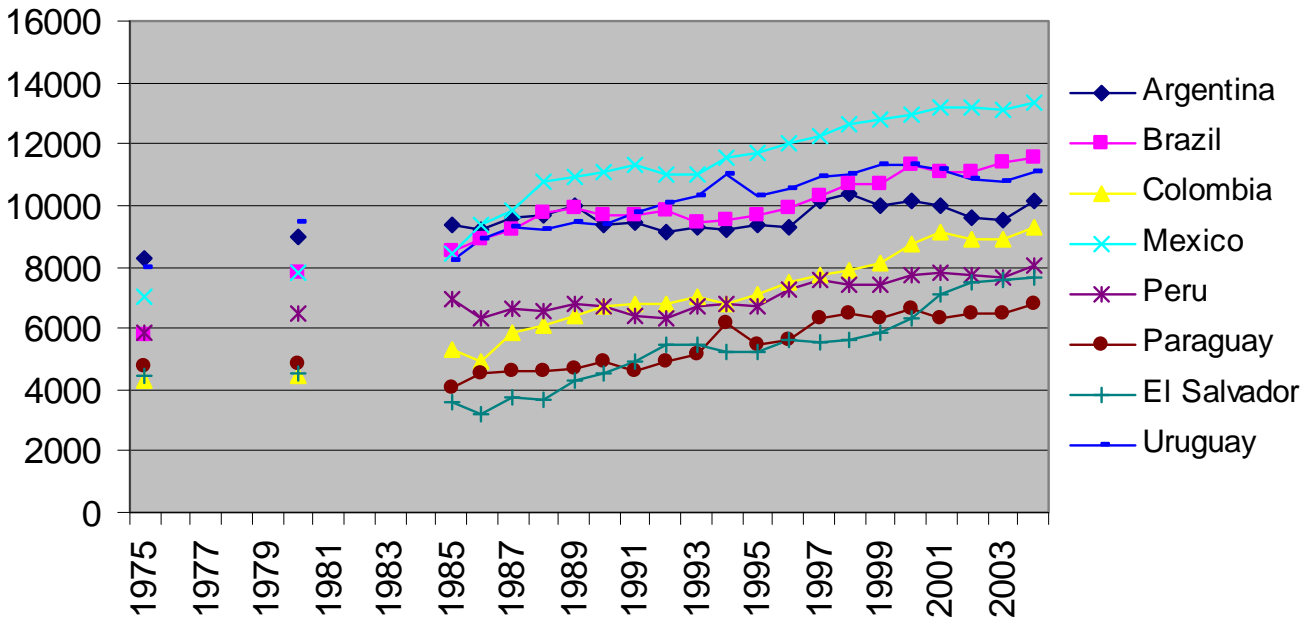


Source: Hausmann, Hwang, and Rodrik (2006).

Given its level of income, Peru is specialized in an unsophisticated export basket. Figure 15 shows the evolution of EXPY over time. Not only is Peru low in the cross-section of countries, but since 1975 the process of “upgrading” the export package and moving to newer, more sophisticated products has lagged in Peru. It began in 1975 at the same level as Brazil, and above Colombia, but has since fallen behind both countries.

Figure 15.

EXPY, Comparative



Source: Authors' calculations using UN COMTRADE.

Consistent with the evidence that Peru did not adjust its export basket in response to changes in relative prices, it has been largely stuck in an unsophisticated export package since 1975 that will not drive future growth.

Why has Peru been unable to discover a sophisticated export basket that could fuel future growth? Hausmann and Klinger (2006) investigate the determinants of the evolution of the level of sophistication of a country's exports, and find that this process is easier when moving to "nearby" products. This is based on the idea that every product involves highly specific inputs such as knowledge, physical assets, intermediate inputs, labor training requirements, infrastructure needs, property rights, regulatory requirements, or other public goods. Established industries have sorted out the many potential failures involved in ensuring the presence of all these inputs, which are then available to subsequent entrants in the industry. But firms that venture into new products find it much more difficult to secure the requisite inputs. For example, they will not find workers with experience in the product in question or suppliers who regularly furnish that industry. Specific infrastructure needs, such as cold storage transportation systems, may be nonexistent; regulatory services, such as product approval and phyto-sanitary permits,

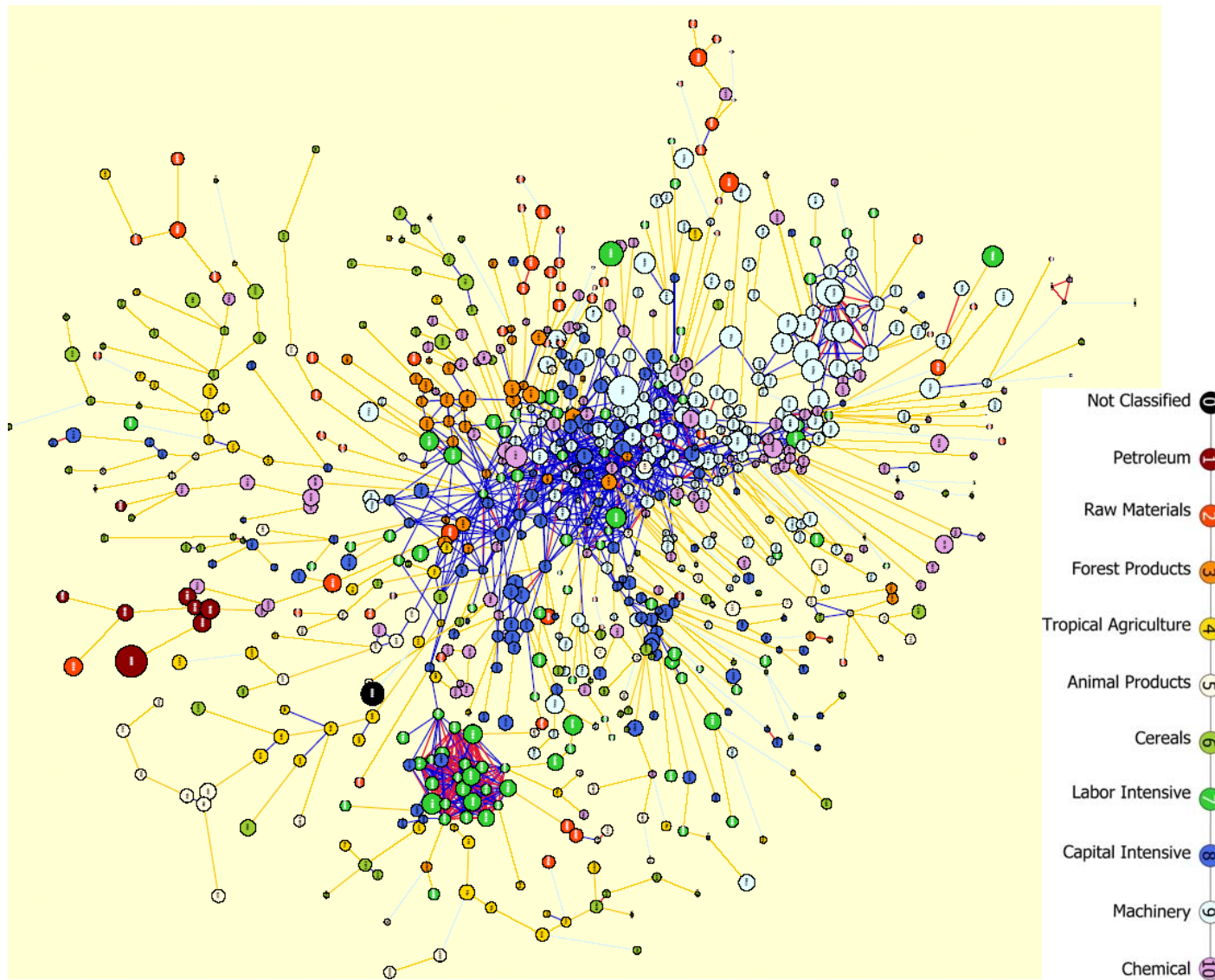
may be underprovided; and there may be no research and development capabilities related to that industry.

The firms moving to new activities will therefore have to adapt whatever capabilities exist. We find evidence supporting the view that the assets and capabilities needed to produce one good are imperfect substitutes for those needed to produce another good, but the degree of asset specificity varies. The probability that a country will develop the capability to be good at producing a particular new good is therefore related to its installed capability in the production of other similar or nearby goods for which the currently existing productive capabilities can be easily adapted. The barriers preventing the emergence of new export activities are less binding for nearby products, which only require slight adaptations of existing capacity.

We developed a measure of “near” using the probability of exporting comparative products, calculated using international data. We then showed that these distances condition the process of discovery. See the Appendix for technical details.

We can visualize these distances by drawing a map of the international product space, which is shown in Figure 16. Each node is a product, its size determined by its share of world trade. In Figures 16 to 18, “nearness” is shown by color-coding the linkages between pairs of products. A light-blue link indicates proximity of less than 0.4, a beige link a proximity between 0.4 and 0.55, a dark-blue link a proximity between 0.55 and 0.65, and a red link a proximity greater than 0.65. Links below 0.55 are only shown if they make up the maximum spanning tree, and the products are color-coded based on their Leamer (1984) commodity group.

Figure 16. A Visual Representation of the Product Space



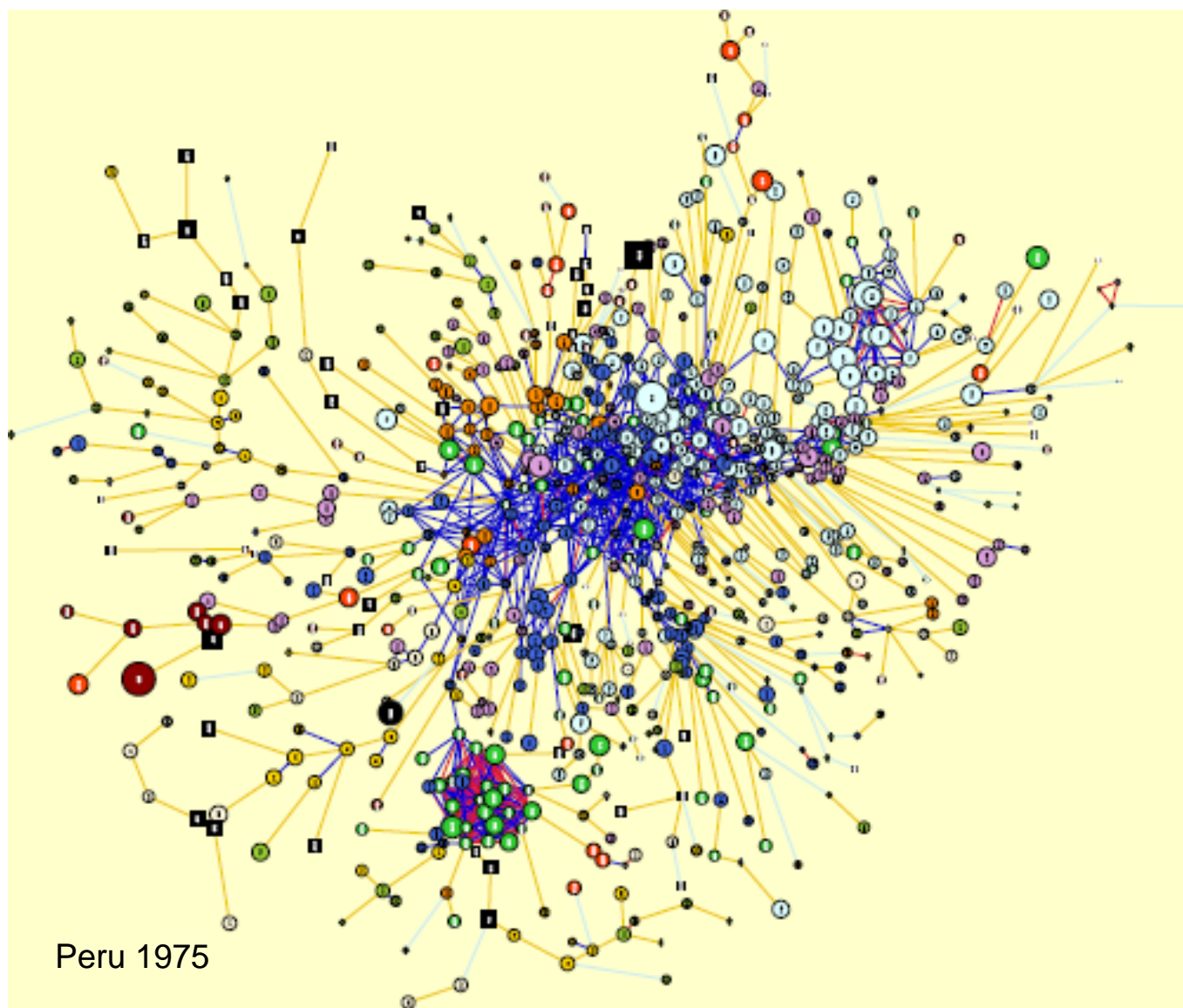
Source: Hidalgo et al. (2007).

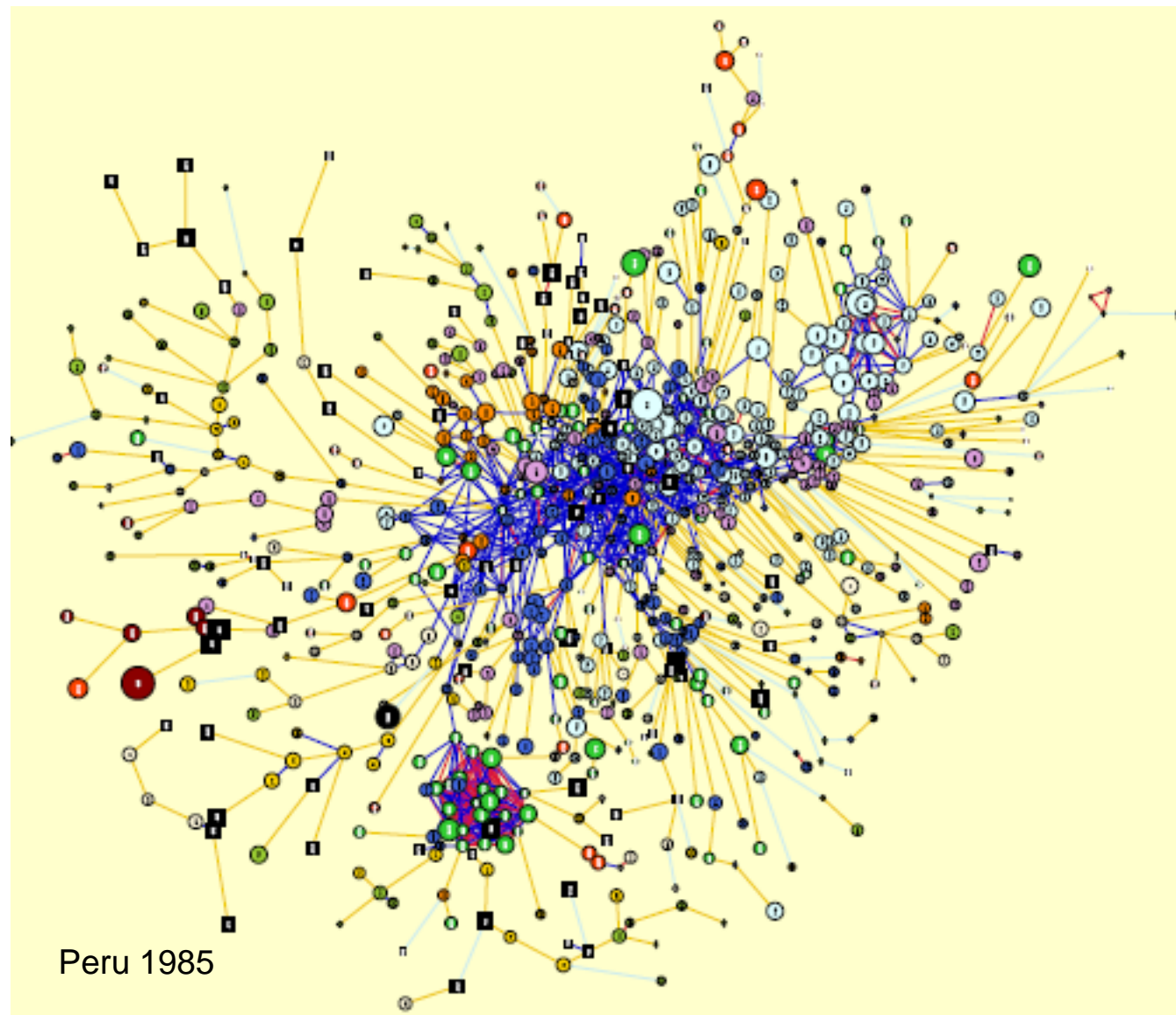
We can immediately see from Figure 16 that the product space is highly heterogeneous. There are peripheral products that are only weakly connected to other products. There are some groupings among these peripheral goods, such as hydrocarbon products (the large red nodes on the left side of the network), seafood products (below hydrocarbon products), garments (the very dense cluster at the bottom of the network), and raw materials (the upper left to upper periphery). Furthermore, there is a core of closely connected products in the center of the network, mainly of machinery and other capital intensive goods.

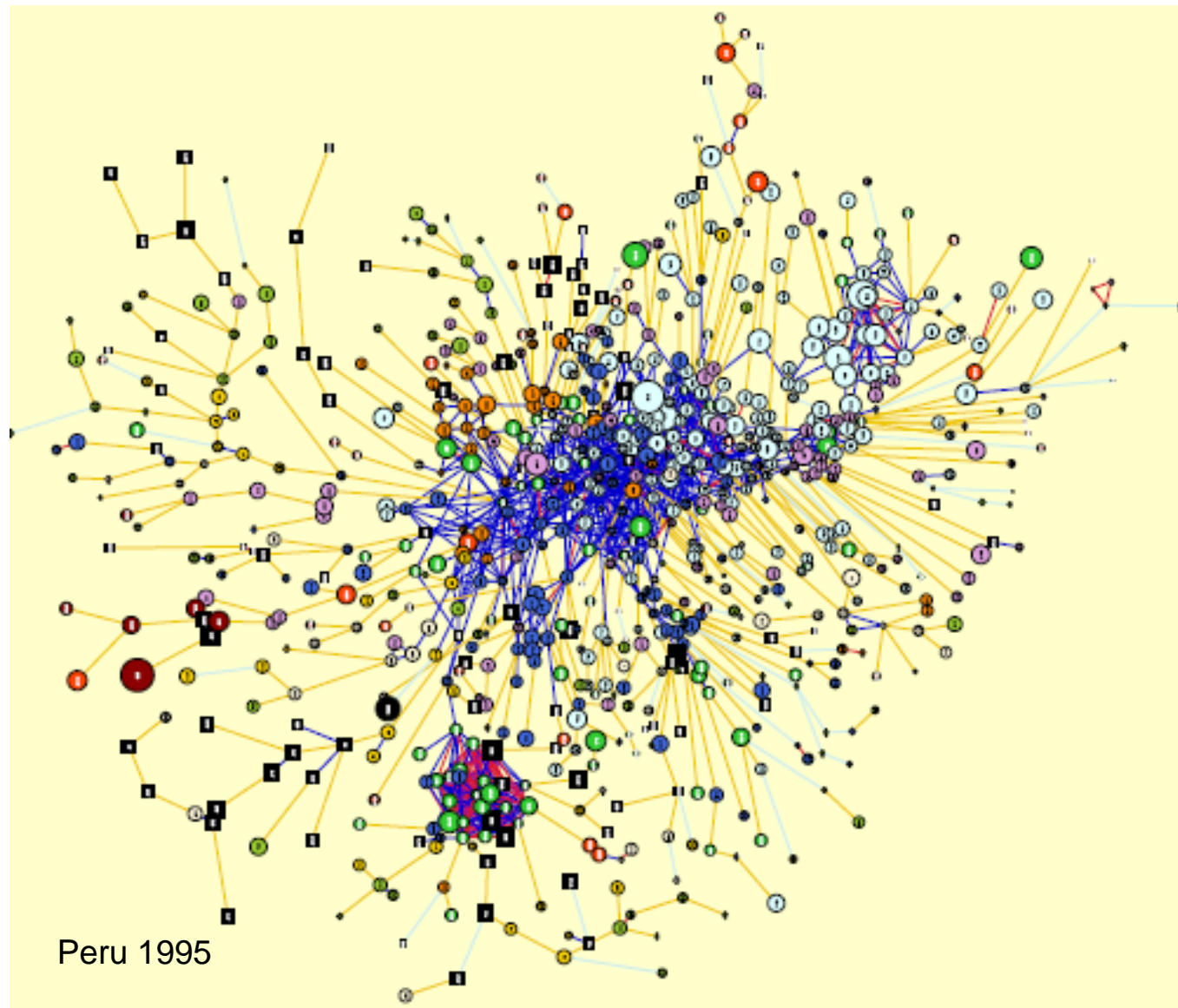
This heterogeneous structure of the product space has important implications for structural transformation. If a country is producing goods in a dense part of the product space, then the process of structural transformation is much easier because the set of acquired capabilities can be easily redeployed to other nearby products. However, if a country is specialized in peripheral products, then this redeployment is more challenging as there is not a set of products requiring similar capabilities. The process of structural transformation can be impeded due to a country's orientation in this space.

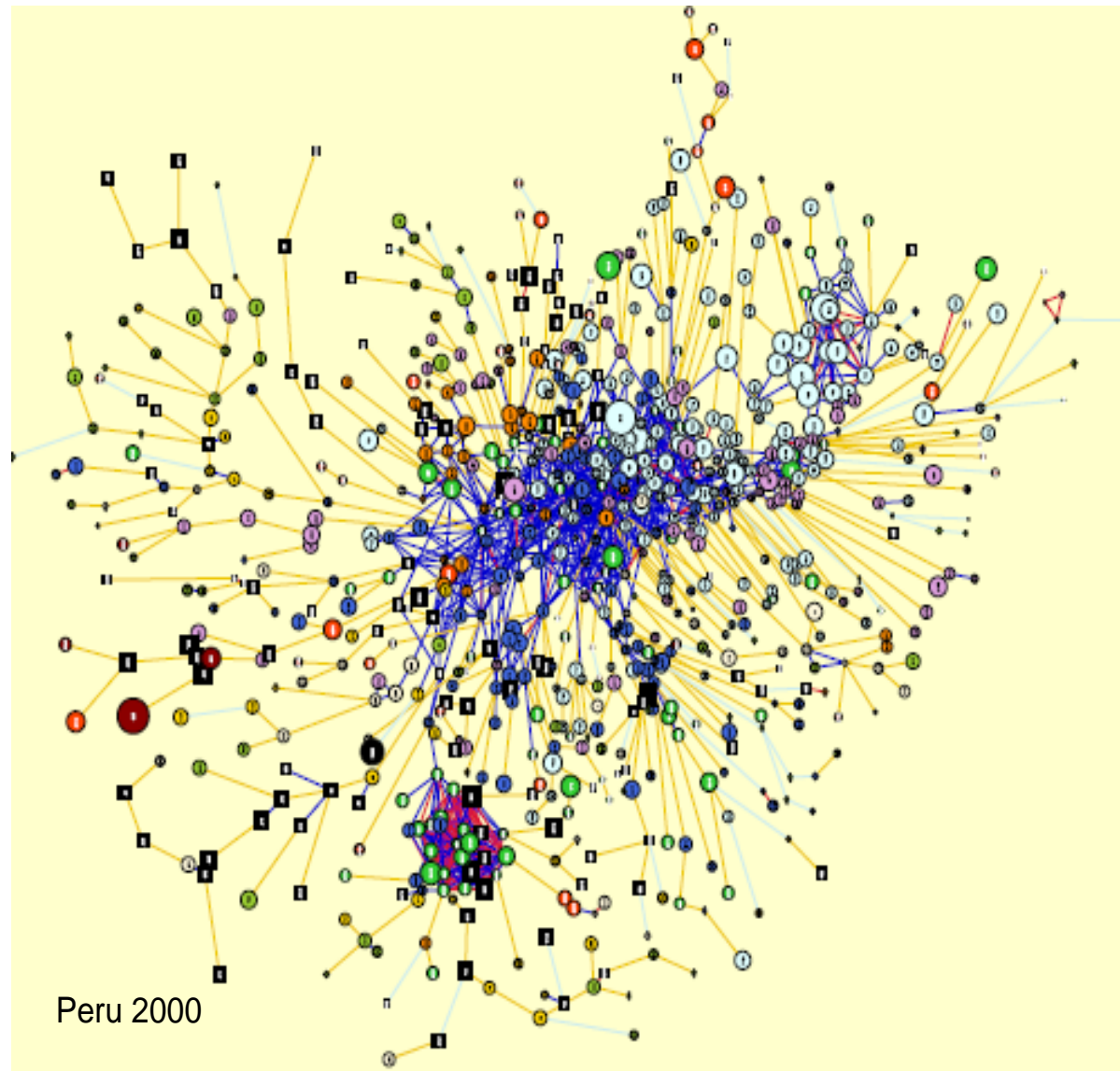
Figure 17 shows Peru's evolution in the product space, where a black square on top of a product indicates that it is exported with comparative advantage.

Figure 17. Peru's Evolution in the Product Space





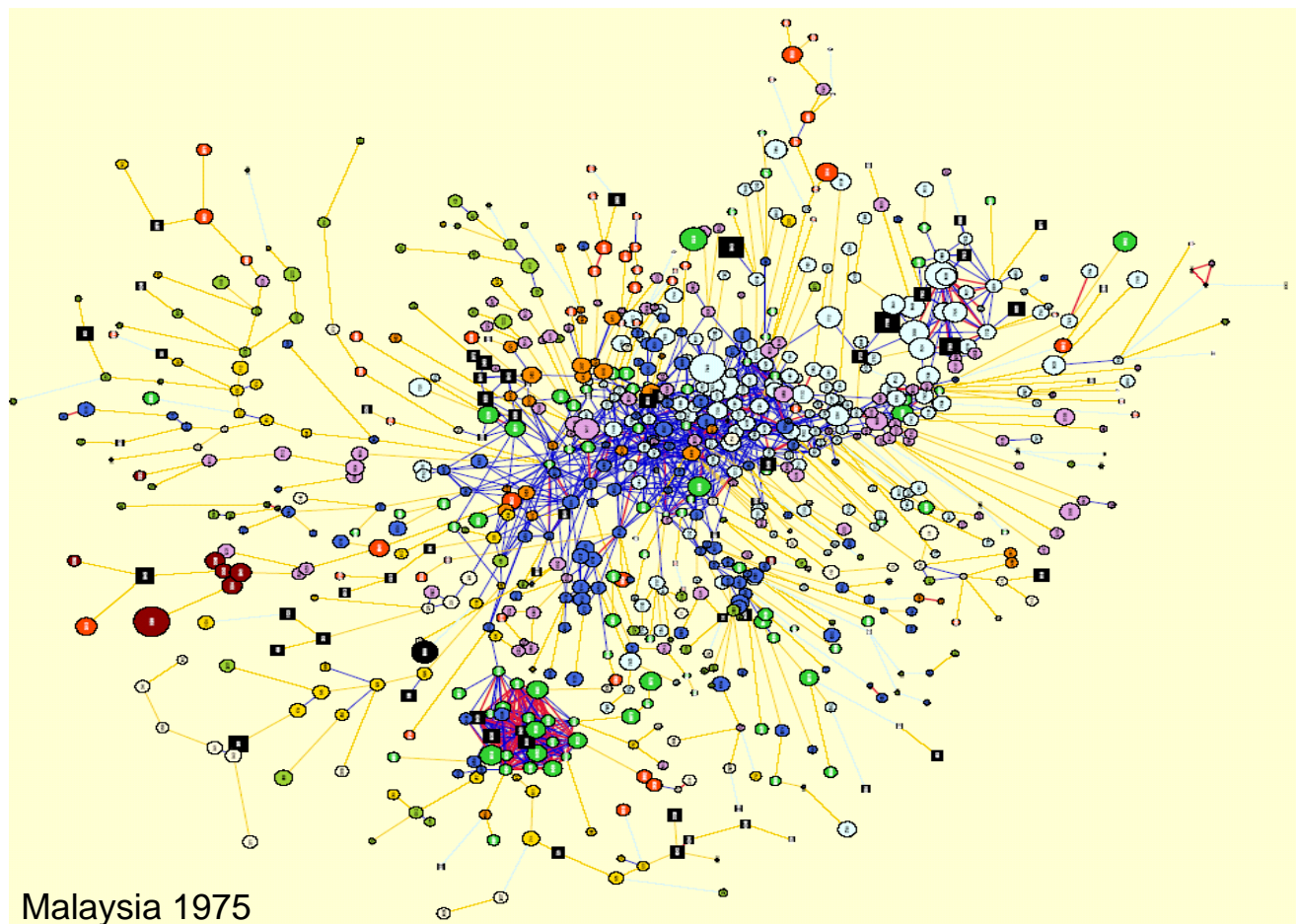


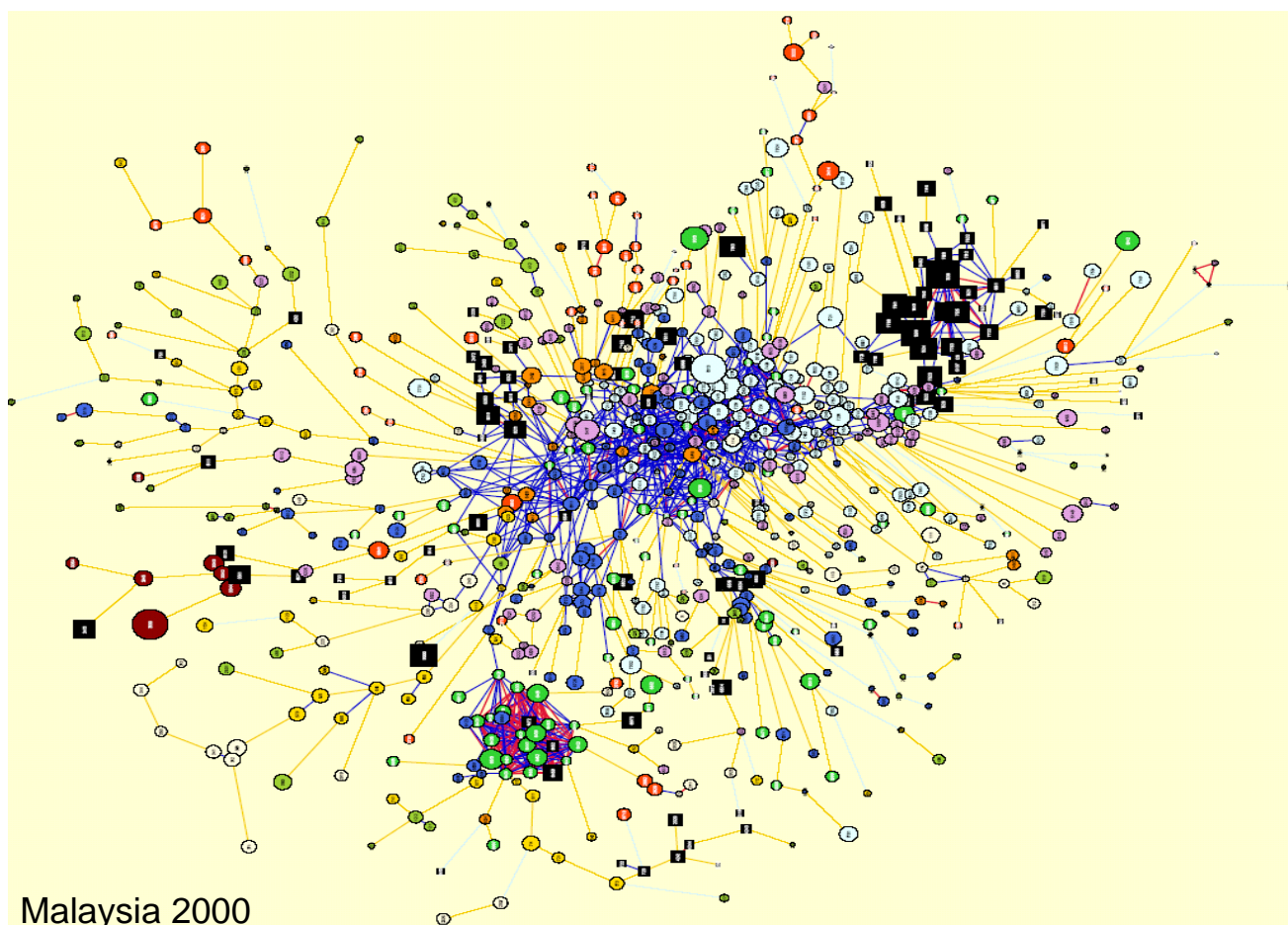


Source: Authors' calculations using UN COMTRADE.

The figure shows that Peru's exports are highly peripheral. More importantly, as seen in the export data examined above, we see little very little change in the deployment of Peru's productive capabilities in the product space between 1975 and 2000, a period that saw a huge export collapse and recovery. Figure 18 shows the case of Malaysia, which has moved significantly and purposefully through the product space in the same period.

Figure 18. Malaysia's Evolution in the Product Space





Source: Authors' calculations.

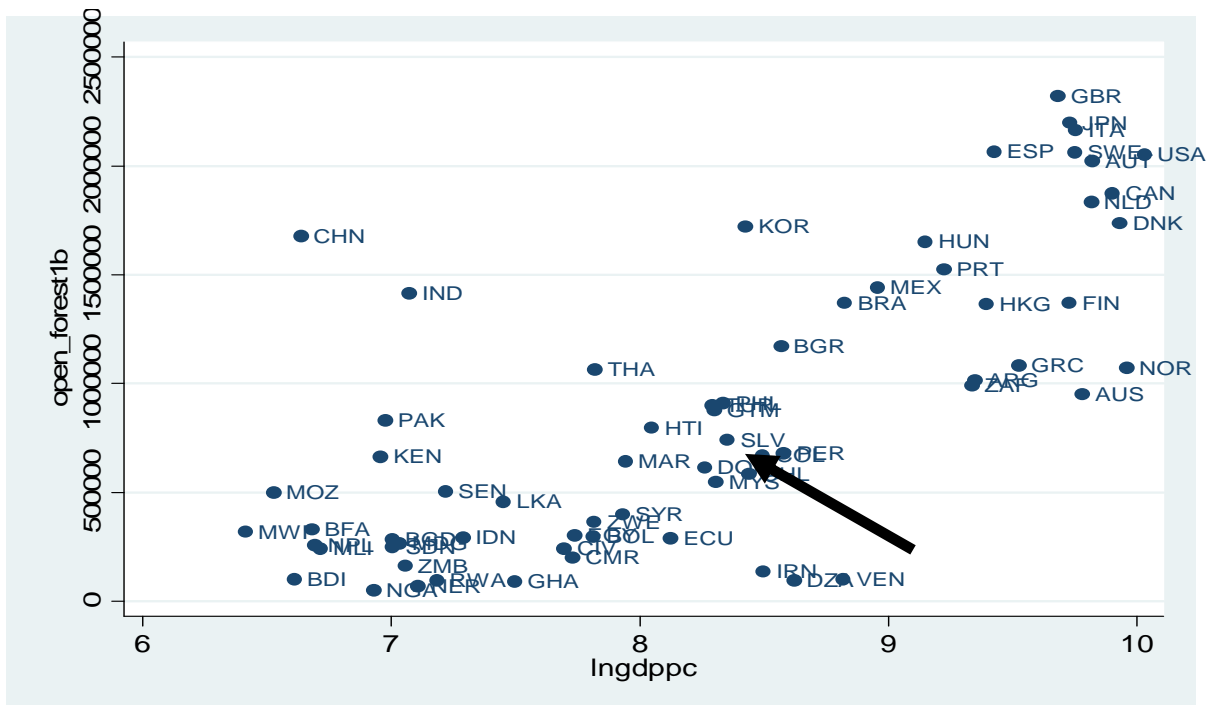
As can be seen in Figure 17 for Peru and Figure 18 for Malaysia, black squares tend to emerge closer to other black squares, meaning structural transformation favors nearby products. This fact is shown econometrically in Hausmann and Klinger (2007). It implies that Peru's opportunities for structural transformation after its main exports suffered headwinds in the late 1970s and early 1980s were limited to what was nearby.

The country-level measure of how many attractive products are near the existing export package is called "open forest" (see the Appendix). Open forest is highly significant in determining the future growth of export sophistication (Hausmann and Klinger, 2006). Countries with a high level of open forest enjoy faster subsequent growth in export sophistication and overall economic growth. Moreover, Hausmann, Rodriguez, and Wagner (2006) show that countries with a higher level of open forest experience shorter growth collapses: they are able to more quickly and easily redeploy their productive capabilities to new export activities. This is

critical, as Peru is a clear case of a growth collapse with little structural transformation in response.

Figure 19 shows open forest on the y-axis against the log of GDP on the x-axis in 1980. Around the time Peru suffered its export collapse, it had a lower value of open forest. Figure 19 suggests that Peru did not have a very valuable option set for structural transformation when it suffered its export shock.

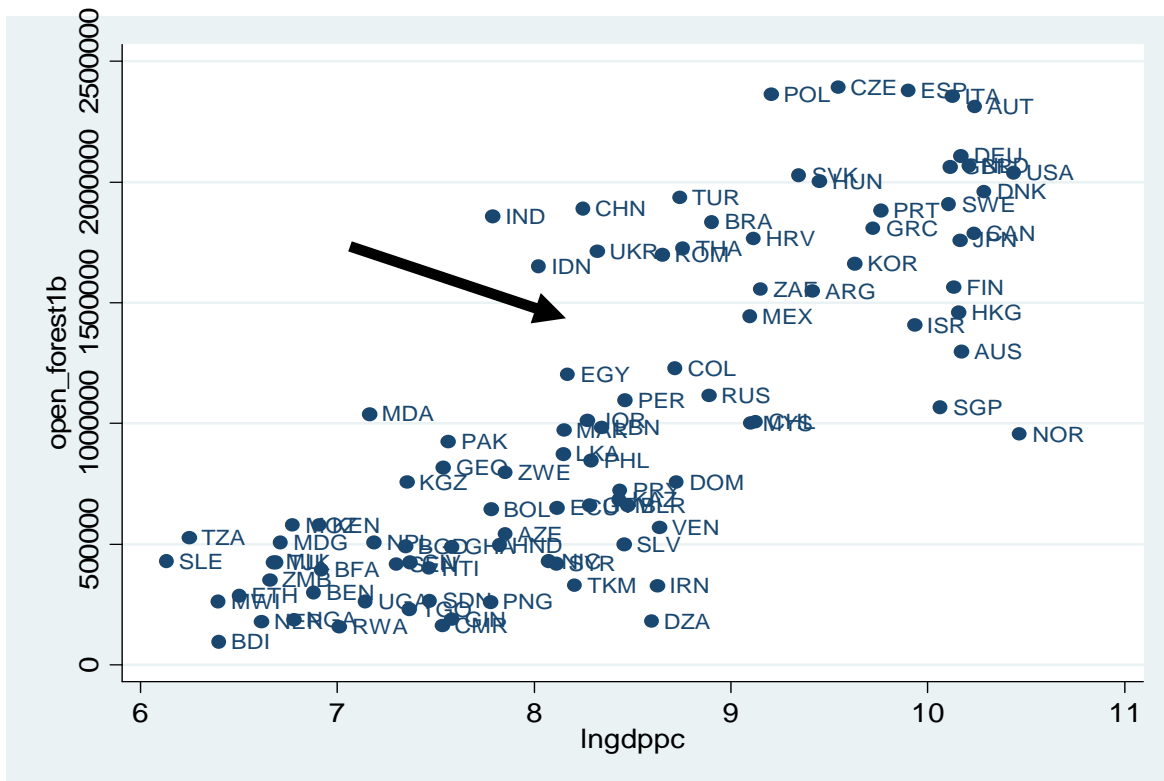
Figure 19. GDP per Capita vs. Open Forest, 1980



Source: Authors' calculations using UN COMTRADE.

What about the role of coordination failures today? Figure 20 shows the equivalent plot for 2000.

Figure 20. Open Forest vs. GDP per Capita, 2000

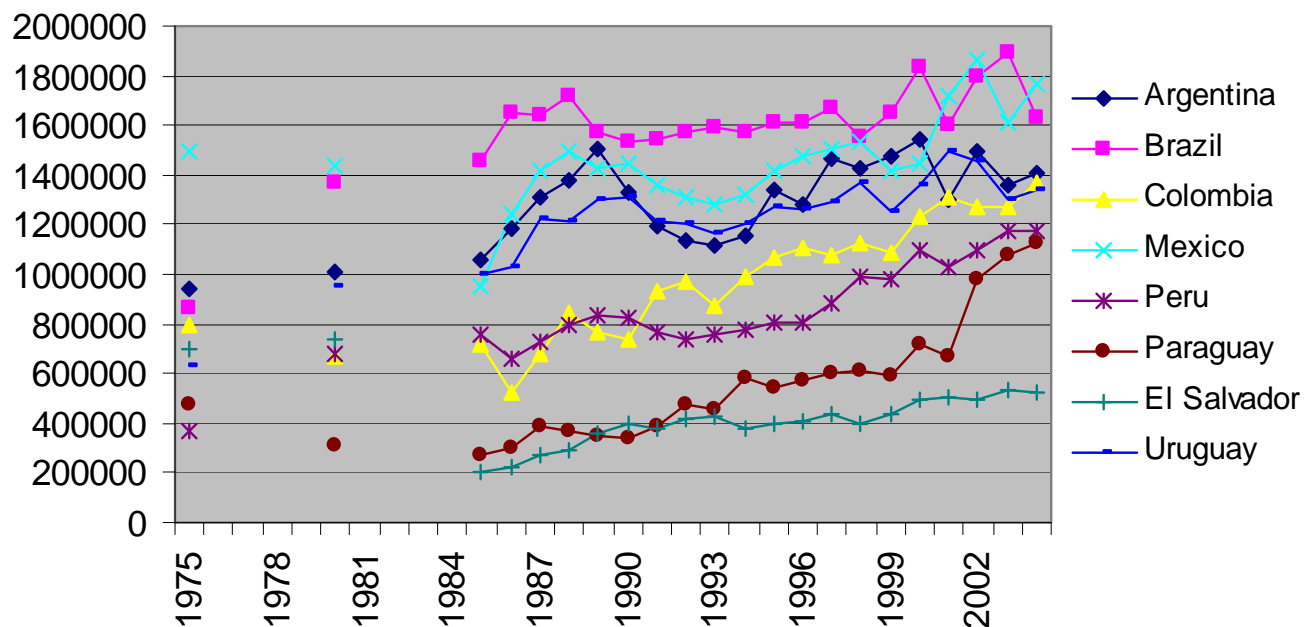


Source: Authors' calculations using UN COMTRADE.

Peru's open forest improved between 1980 and 2000. We show this evolution over time compared with other Latin American economies in Figure 21.

Figure 21.

Open Forest, Comparative



Source: Authors' calculations using UN COMTRADE.

In terms of export sophistication (EXPY), Peru has fallen behind. But in terms of opportunities for future structural transformation (open forest), relative performance is not as bad. Nevertheless, Peru's option set for future structural transformation remains below that of Argentina, Brazil, Mexico, Uruguay, and Colombia.

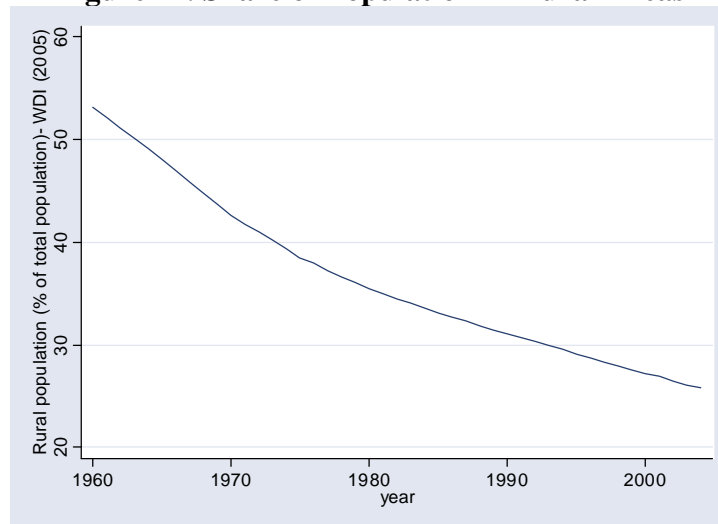
For the purpose of deriving policy implications, it is useful to examine what sectors make up the set of attractive nearby opportunities. Table 1 lists the main contributors to Peru's open forest as of 2004. These are the existing sectors in Peru that have the largest number of unexploited sectors nearby, to which Peru could conceivably move.

Table 1. Top Contributors to Open Forest, 2004

Product Code	Product Name	Contribution	Exports (M)
7228	Other bars and rods of alloy steel;	32408	23
307	Molluscs & aquatic invertebrates,ne	29532	123
306	Crustaceans,fresh,chilled or frozen	27000	26
713	Dried leguminous vegetables, shelle	24907	15
511	Animal products, nes; dead of Chapt	23178	6
305	Fish,salted,dried...;smoked fish;fi	22176	6
2835	Phosphinates, phosphonates, phospho	20822	9
304	Fish fillets and other fish meat, f	18093	48
712	Dried vegetables, whole, cut, slice	17524	14
711	Vegetables provisionally preserved,	17315	10
703	Onions, shallots, garlic, leeks...e	15947	14
9608	Ball point,felt,porous-tipped pens,	14998	7
2833	Sulphates; alums; peroxosulphates (13530	7
811	Fruit and nuts, frozen	13514	5
801	Coconuts, Brazil nuts and cashew nu	13050	10
710	Vegetables, frozen	13017	22
901	Coffee; coffee husks and skins; cof	12017	290

Source: Authors' calculations using UN COMTRADE.

As highlighted by the red squares, the top contributors to open forest are almost all concentrated in seafood, fruits and vegetables, and processed food products. Most of these products are in the non-traditional agriculture sector, which we saw earlier was the new contributor to the export recovery in the 1990s. This evidence suggests that there remain as of yet unexploited opportunities in this sector. However, the difficulty is that many of the activities in this sector use rural employment, whereas a large and increasing share of Peruvians live in urban zones (Figure 22).

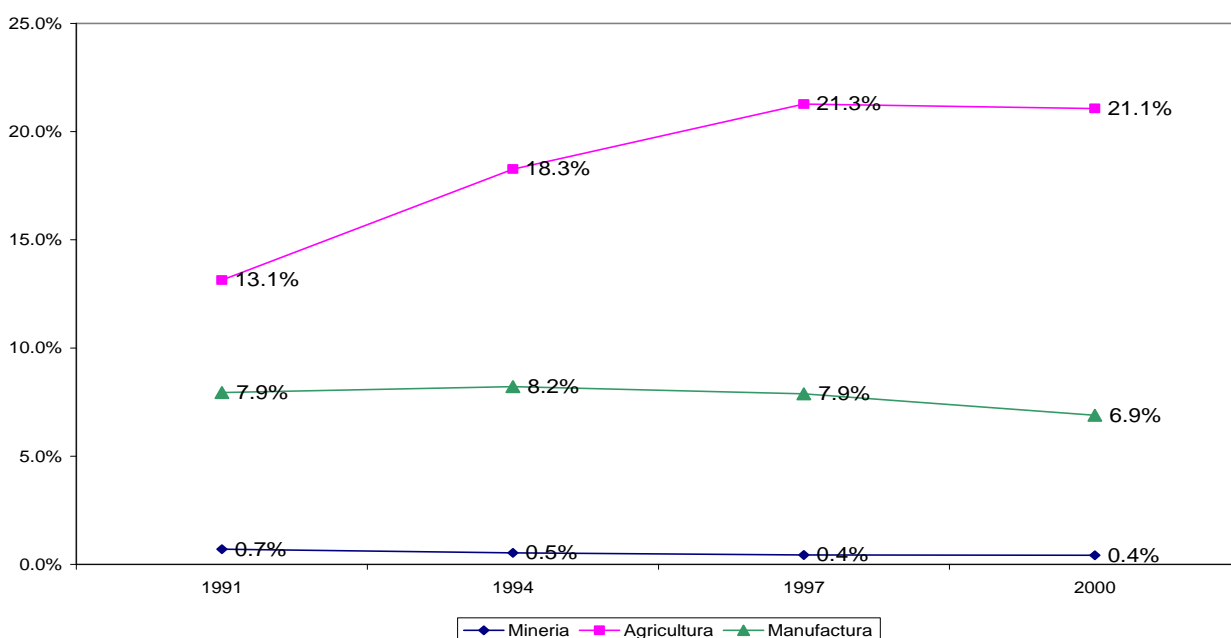
Figure 22. Share of Population in Rural Areas

Source: WDI.

Not only are these “higher-potential” new sectors a mismatch with Peru’s labor market, but the existing export sectors are as well. Mining, which is leading the export recovery, is extremely un-intensive in labor, as shown in Figure 23. Although mining accounts for 60 percent of exports, it represents less than 0.5 percent of (direct) employment. Furthermore, while mining exports skyrocketed from 1991 to 2000, employment in the mining sector as a share of the working age population actually decreased.

**Figure 23. Decomposition of Employment in the Tradable Sector
(Employment / working age population)**

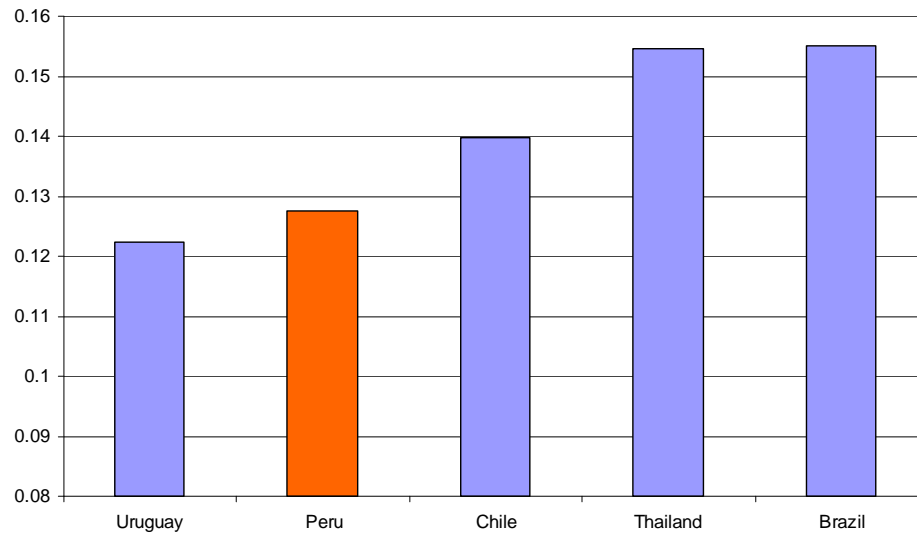
**Descomposicion del Empleo en Sector Transable
(Ocupados/ PET)**



Source: National Surveys of Standards of Living.

Moreover, compared with mining-focused Chile, Peru’s export basket is particularly un-intensive in labor. Figure 24 shows the labor intensity of exports, constructed using labor shares from the United States’ input-output table by product, weighted by their share in overall exports. Peru’s export basket is less intensive in labor than Thailand’s and Brazil’s, but also less intensive than Chile’s, whose export composition is dominated by copper, but compensated for by other, more labor-intensive sectors.

Figure 24.
Labor Intensity of the Export Basket, 2005



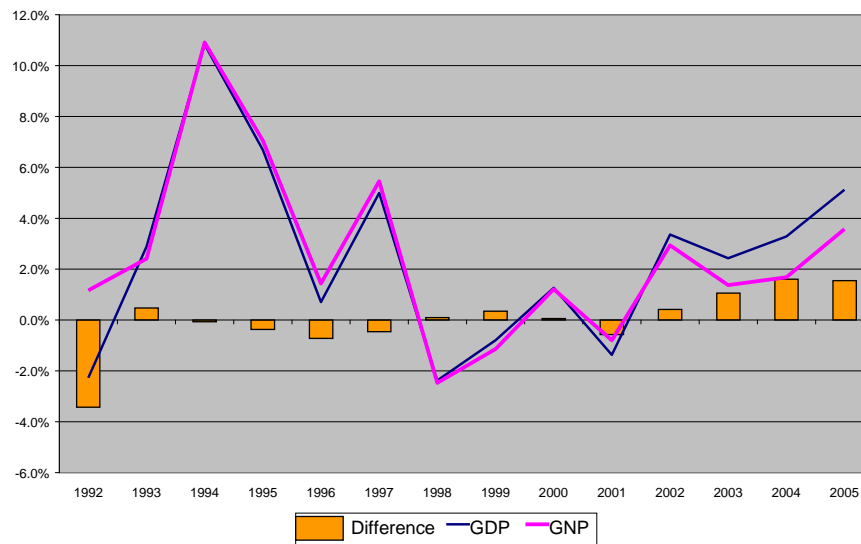
Note: Labor's share in total value added taken from the 1997 U.S. Input-Output table, as this is the most disaggregated source by product (241 NAICS sectors). This is translated to the SITC revision 2 coding system, giving a labor share value for each export. Country values are taken as the export-share weighted value of these intensities, for the 2005 export basket.

Source: UN COMTRADE and U.S. Bureau of Economic Analysis.

The dominant export sectors in Peru's economy generate little employment. This is important because unlike non-tradable sectors, export sectors are highly scaleable. At international prices, demand is almost infinite from the point of view of Peru. Therefore, if the sector is moderately labor intensive, it could contribute significantly to employment generation.

Instead, mining is highly capital intensive. However, much of this capital is in the form of foreign investment, and therefore the returns accrue to the foreign owners of that capital. This can be seen by considering the differences in the growth rate of GDP and gross national income (GNI), which are shown in Figure 25. Since 2001, the growth rate of overall GDP has been faster than GNI. This gap in growth rates has been increasing, and as of 2005 was well over 100 basis points.

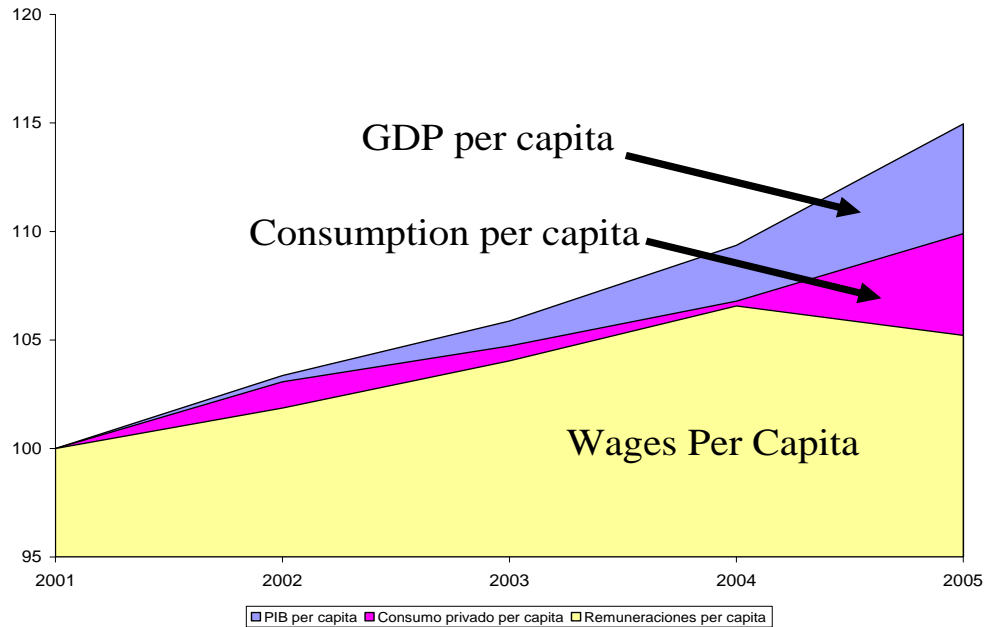
Figure 25. Growth Rates of GDP and GNP



Source: WDI.

The fact that the leading sectors have been capital intensive is behind the muted social impact of growth. This can be seen by looking at the evolution of GDP per capita in comparison with consumption per capita or the real wage bill per capita (from the national accounts). Figure 26 shows index numbers for the three series (2001=100). It shows that consumption has grown slower than aggregate output. Wages have grown at an even slower pace, and actually declined between 2004 and 2005, at the same time that economic growth was accelerating.

Figure 26. Economic Performance in Peru since 2001



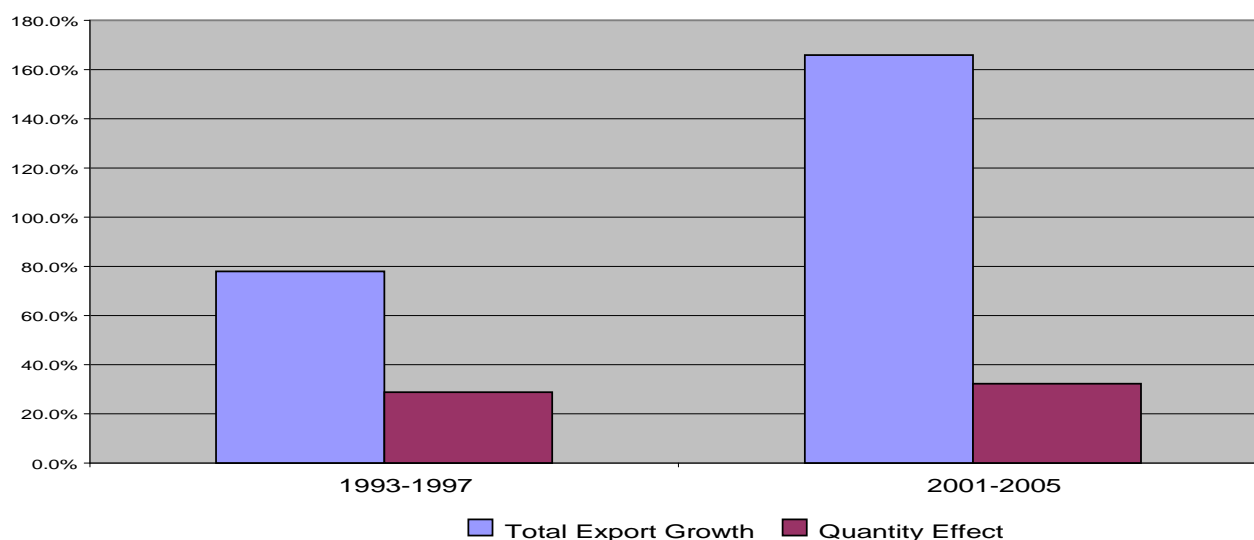
Source: BCRP.

To summarize, this analysis reveals three key findings related to structural transformation. First, the lack of new export activities appearing in Peru's export basket is due in no small part to the nature of Peru's specialization. When the country's main exports faced international price shocks, there were few nearby goods to move to, and consequently the country suffered a growth collapse. Second, unlike in the 1980s, Peru is in a slightly better position today for structural transformation, with new export sectors nearby. However, these opportunities are concentrated in sectors that use more rural labor in an increasingly urbanized country, and other existing opportunities require little labor. Structural transformation in the direction of new sectors intensive in urban labor will require longer jumps, which are difficult to achieve. The final section on policy implications provides some guidance in this regard.

Third, in addition to the lack of new goods appearing in Peru's production function, which appears to be the most significant constraint to growth, there are other constraints on the aggregate production function. For example, there is uncertainty due to Peru's history of appropriation in the natural resource sector.

A symptom of this constraint is the muted supply response to the recent improvement in the terms of trade. Figure 27 shows recent overall export growth in blue, and the component of that growth that is through an increase in quantities in purple, first from 1993 to 1997, then from 2001 to 2005. Little of the current growth in exports is from increased production.

Figure 27. Overall Export Growth and Change in Quantity



Source: Authors' calculations using IFS.

More revealing is that Peru lost market share in the main export products that were hit by adverse prices. If the export collapse was purely due to a deterioration in the terms of trade, earnings should fall but market share should remain constant. In fact, given that Peru was in such a poor position to move to any alternative export goods, and failed to do so, its market share should have in theory increased as other more nimble countries moved to new export activities in response to the change in relative prices. But Peru lost market share, indicating that it was not only an exogenous shock that brought exports down. Instead, a history of expropriation seems to precede these collapses. For example, in the agriculture sector, the agrarian reform of 1969, which by 1975 affected nearly all plantations, preceded the cotton and sugar collapse in the early 1980s. Fishing collapsed in 1972 for environmental reasons, but Peru nationalized the industry and went on to create PescaPeru in 1973 and then had to abandon it in 1976 as it was never able to return to previous levels of production. In the mining sector, the government began revoking concessions in the 1970s, and created Minero Peru. In 1973, the government completely

nationalized the mining complex in Cerro de Pasco. Due to the development of the Cuajone mine in 1976, a decline in production was not immediate, but by the 1980s, copper and silver mining collapsed. The Marcona mining company, which exported iron ore, was expropriated in 1975. Iron ore production declined until its complete collapse in 1990. The same cycle can be observed in the hydrocarbon sector. First the sector was nationalized and PetroPeru was created in 1968. PetroPeru expanded significantly in the 1970s, thanks to the opening of the northern pipeline. But after 1980, hydrocarbon production fell significantly.

Nationalizations left a property rights regime that made it essentially impossible for international investors to invest in exploration or production in the mining or energy sectors in response to the export collapse in the 1970s and 1980s. Moreover, potential investors in other sectors were aware of this history of expropriation. Hence, investment in these sectors did not recover until the government improved the property rights regime and adopted generous levels of taxation and guarantees of tax stability for foreign investors.

The difficulty is that these concessions do not recover much of the natural rent that the government could receive from natural resource exports, limiting the impact of these activities on national income and the social benefit that could potentially derive from it. This in turn limits the long-term political sustainability of such concessions, as could be seen in the most recent electoral cycle where natural resource rents were a key area of contention. The perceived low sustainability of generous concessions increases the long-term risk of appropriation facing foreign investors, who then demand more attractive concessions so that they can be sure to recoup their investment before they are expropriated. This creates a vicious cycle that is difficult to break, and is a key constraint in the natural resource sector of the economy, particularly mining and hydrocarbons. Another piece of supporting evidence is that the only new activities to emerge (the non-traditional export sector) have been in areas not affected by the agrarian reform and in smaller landholdings that are not as sensitive to large-scale expropriation.

Nevertheless, in many other potential export activities, there is little history of expropriation. Moreover, as discussed below, Peru fares quite well in terms of investor confidence and governance indicators. Therefore, we take this constraint to be second-order. The principal binding constraint to growth is the lack of structural transformation and few nearby, urban, labor-intensive export sectors.

Incompatible Constraints

In this section we explore other potential obstacles to growth. We find few arguments to support that inadequate access to savings has been a major constraint to growth in Peru in the recent past, as investment has been unresponsive to the greater availability of finance. We also find little evidence that inadequate human capital is an obstacle, as the levels of education have increased rapidly and the returns to schooling have remained relatively low and stable in spite of the recovery in growth.

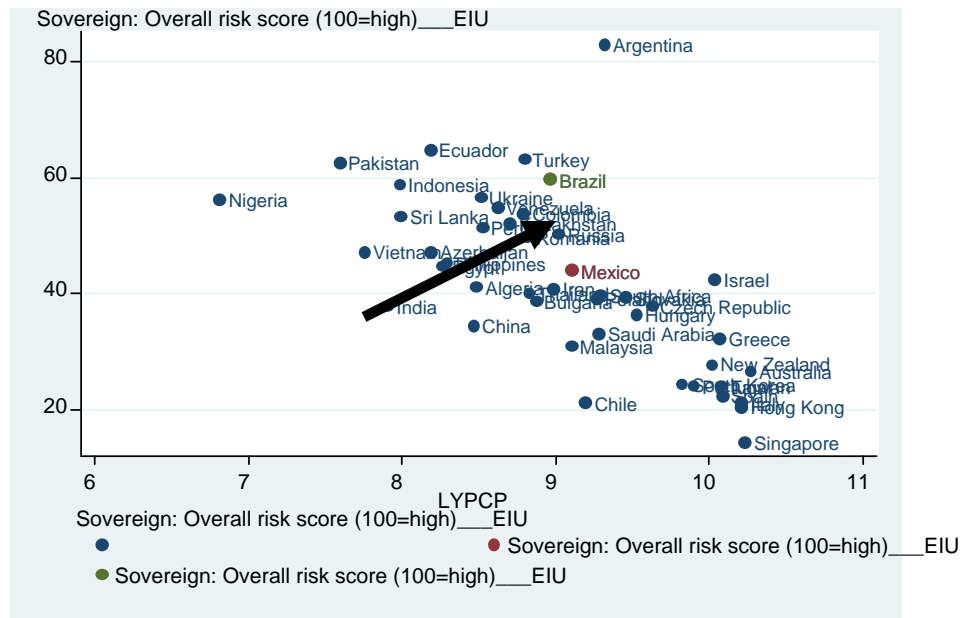
We explore other potential binding constraints but find them less relevant to the present situation of Peru. Ideally we would want to show that changes in a binding constraint have large effects on growth. We find this in the dynamics around the export sector, but fail to find it in aspects such as labor regulation, taxation, macroeconomic stability, and crime (post Sendero Luminoso).

Bad Finance

As mentioned above, problems with external balance, government debt, inflation, and the financial system happened after the export-led growth collapse. Over the past 15 years, the current account has been narrowing, the debt to GDP ratio has fallen, and the cost of capital has declined. This suggests that access to savings has not been a binding constraint over the past 7 years, as the country has had more access to finance than it was willing to use.

Moreover, the country is not facing expensive foreign finance due to a high risk of default (Figure 28). The country's debt trades as if it was investment grade and it is not far from formally achieving this status. From the Economist Intelligence Unit, the risk score for Peru's sovereign debt is well below that of other Latin American countries, such as Argentina, Ecuador, Brazil, and Venezuela, and second only to Chile and Mexico.

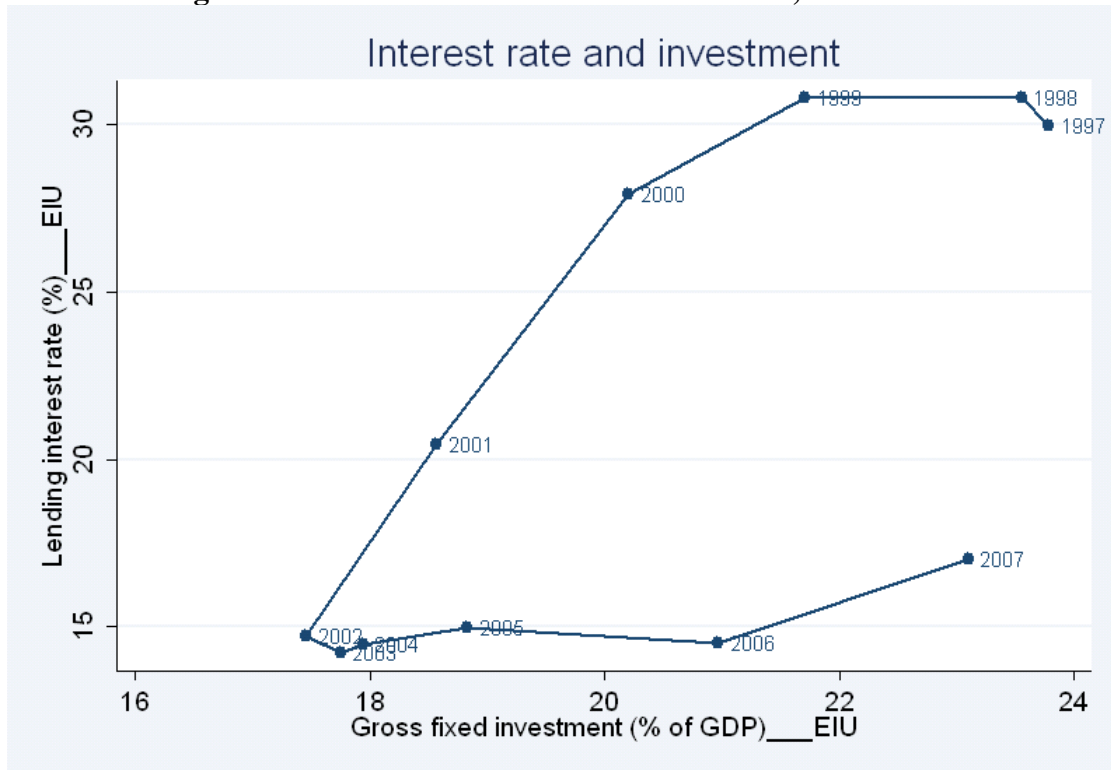
Figure 28. EIU Sovereign Debt Risk Score vs. GDP per Capita (log)



Source: EIU and WDI.

But most importantly from the point of view of growth diagnostics, we do not see that investment is sensitive to the interest rate. Figure 29 shows investment on the x-axis and the lending interest rate on the y-axis. From 1997 to 2004, the interest rate fell, and at the same time investment fell. This indicates that it was not the cost of finance that brought down the investment rate, but rather the low level of expected returns. Then from 2004 to 2007, investment rose very significantly with scant movement in interest rates. This suggests that something other than the cost of finance is limiting investment. Changes to the binding constraint should lead to large changes in growth, as the binding constraint should have a large Lagrangian multiplier. But here we see the opposite, suggesting that although the present government's desire to achieve investment grade is not a bad idea, it is not targeting a binding constraint, and therefore will not have much of a growth impact. In fact, the difference between the cost of capital in Peru and investment-grade Mexico is now barely 20 basis points (EMBI differential, BCRP, June 2007), which is miniscule relative to the changes in interest rates we have already seen.

Figure 29. Peru's Interest Rate vs. Investment, 1997 - 2007



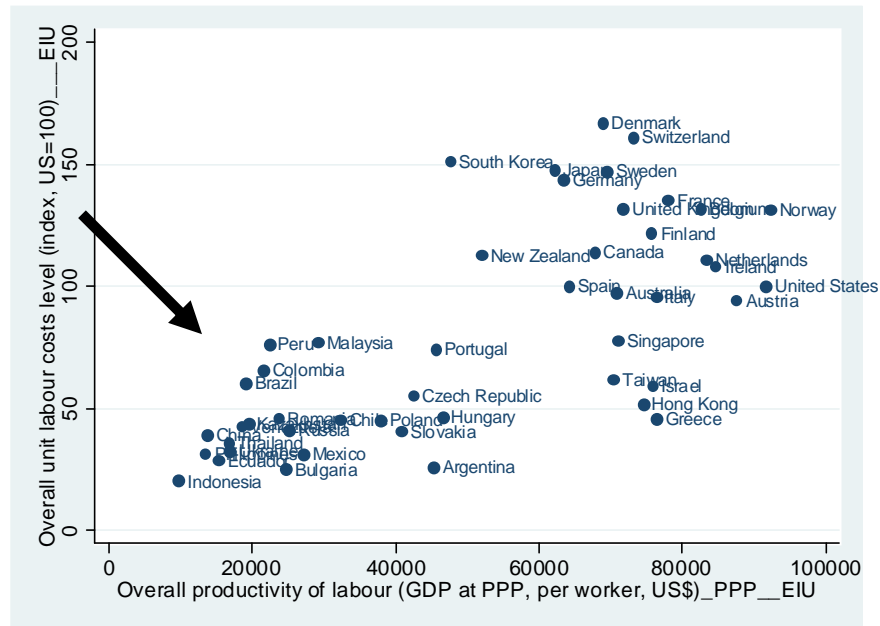
Source: EIU.

In Peru, lack of aggregate finance is clearly not the problem. We are seeing low investment despite good access to external finance, a low current account deficit, and little responsiveness of lending to interest rate changes. This is consistent with the detailed analysis in Braun and Serra (2006), who find that the bulk of recent GDP performance is not explained by financial development, and therefore we abandon this side of the decision tree and move on to low returns.

Labor and Business Regulations

The evidence in this area of the decision tree is mixed. Figure 30 shows that the cost of labor in Peru is high given productivity levels. Unit labor costs are at the same levels as those in Malaysia, Portugal, and even Singapore, but productivity is much lower.

Figure 30. Labor Costs vs. Labor Productivity

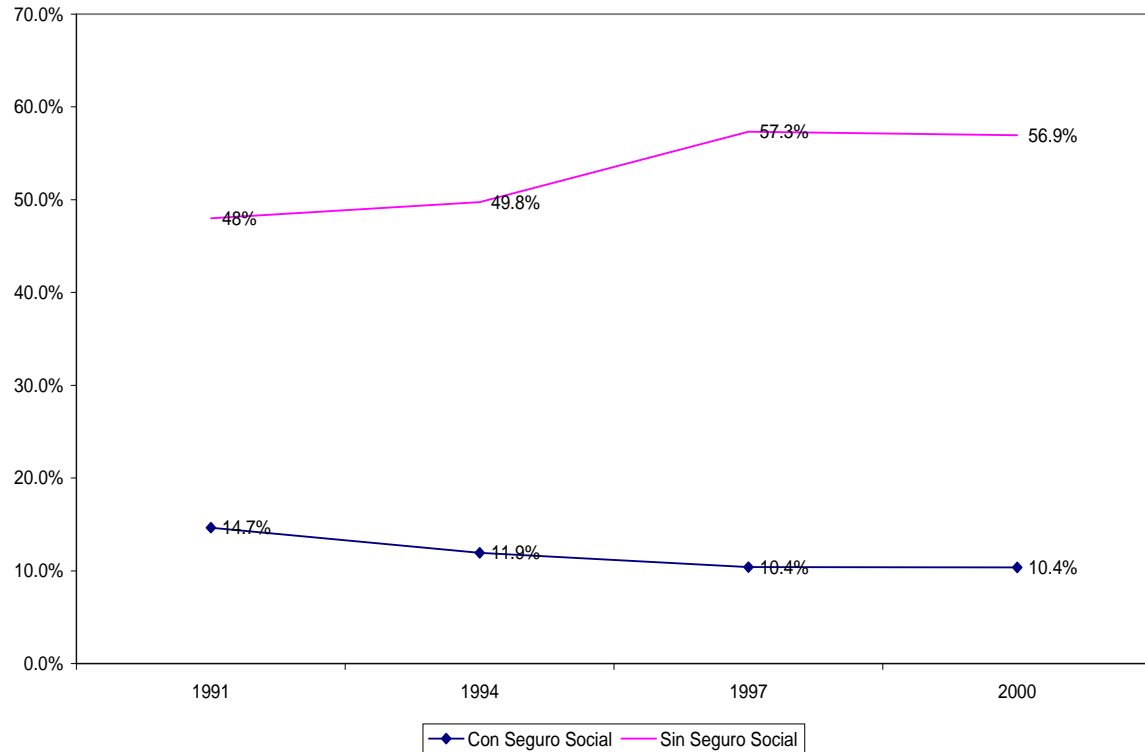


Source: EIU.

Another telling factor is the rate of informality in Peru. During the export and output recovery in the 1990s, the percentage of dependent workers (as opposed to self-employed or employers) without social security actual rose, while the percentage of those with it fell (Figure 31).

Figure 31.

**Empleados con Seguro Social
(Ocupados/ PET)**

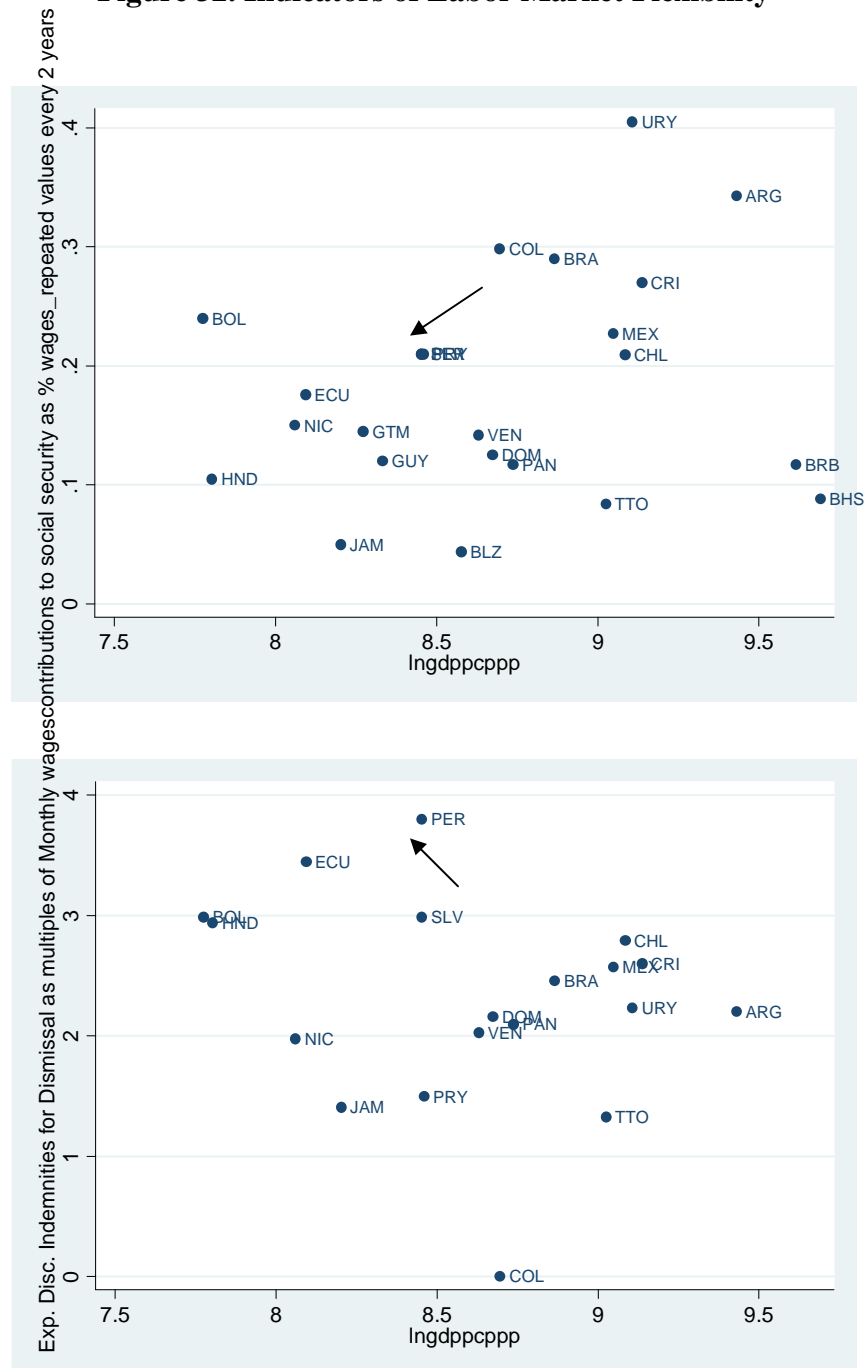


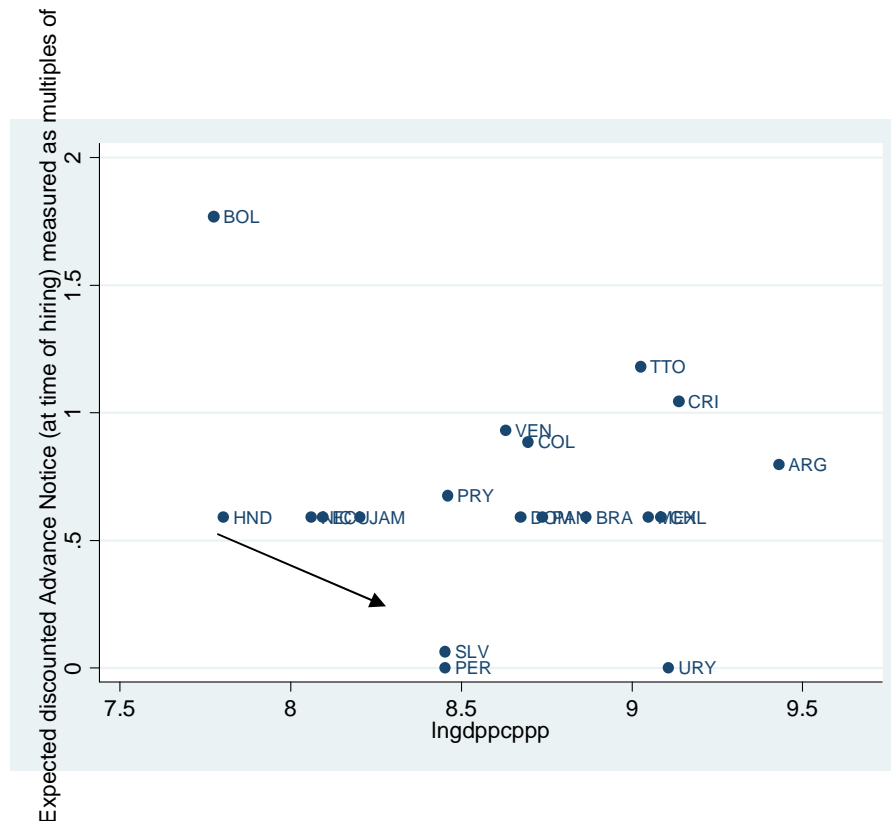
Note: The blue line represents the percentage of workers in the social security system, and the pink line represents the percentage of workers without social security.

Source: Encuestas Nacionales de Niveles de Vida.

However, Peru's Economist Intelligence Unit (EIU) rating for "restrictiveness of labor laws" is 3 (out of 5, with 5 being the least restrictive). The Philippines is the only country in the world with a similar GDP per capita but a better rating (4), and Peru's rating is much better than that of China and India (1). Using other available metrics of labor market inflexibilities, we see that those around social security seem relatively high given Peru's level of income, but others (such as regulations for advance notice of dismissal) are quite low (Figure 32).

Figure 32. Indicators of Labor Market Flexibility





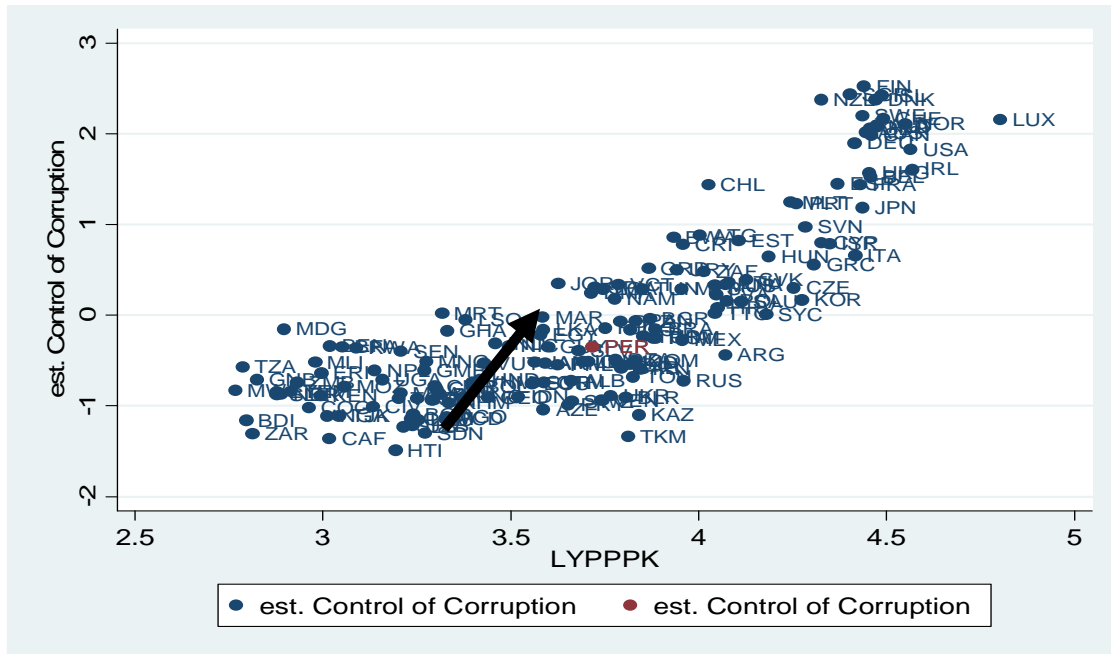
Source: Heckman and Pagés (2003).

On the whole, there is some evidence that this constraint is binding. In particular, it may affect activities that are exposed to international competition and hence affect disproportionately the sectors that are required for structural transformation to take place. Manufacturing activities have not become internationally competitive in spite of a rising urban population with improved educational attainment that is currently employed in low-productivity activities in the informal sector. This points to the possibility that the current labor code is particularly constraining for this sector.

Crime and Corruption

Crime levels in Peru do not seem particularly high. The presence of Sendero Luminoso in the 1980s and early 1990s must have helped explain the poor output performance in that period; but much of the pay-off from the increase in security was probably already reaped in the 1990s. There are plenty of countries with similar or worse indicators for control of corruption, including Mexico and Argentina, which are significantly richer than Peru (Figure 33).

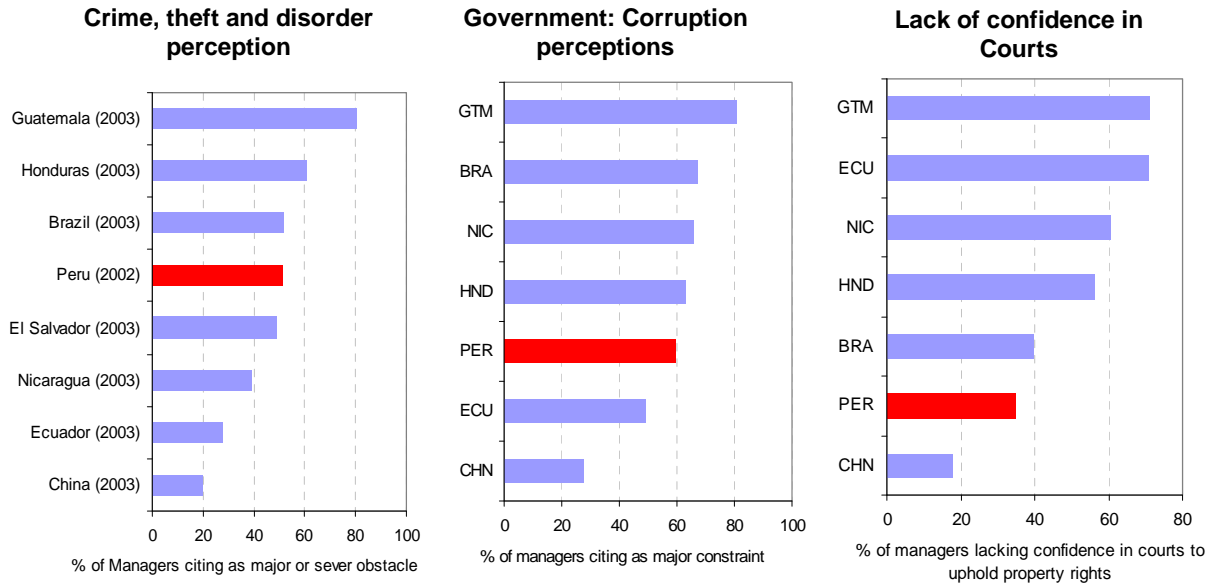
Figure 33. Control of Corruption vs. GDP per Capita (log), 2004



Source: World Bank, and WDI.

Moreover, investors do not seem to find corruption a problem, as evidenced in the Investment Climate Assessment as well as the Kaufman governance indicators (Figure 34).

Figure 34.



Source: ICA WorldBank (2002)

Source: WDI (2002-2003)

Source: WDI (2002-2003)

Note: Adapted from Cubillos et al. (2005).

Finally, both the timing and the severity of the collapse and recovery of exports and output are inconsistent with a story of crime and corruption. Appropriability concerns due to crime and corruption do not seem to be important in the case of Peru.

Taxes

Informality in the labor force could be due to labor market restrictions, but also other regulatory burdens, one of which is taxes. However, Peruvian tax rates are simple, stable, and not high internationally (Table 2).

Table 2.

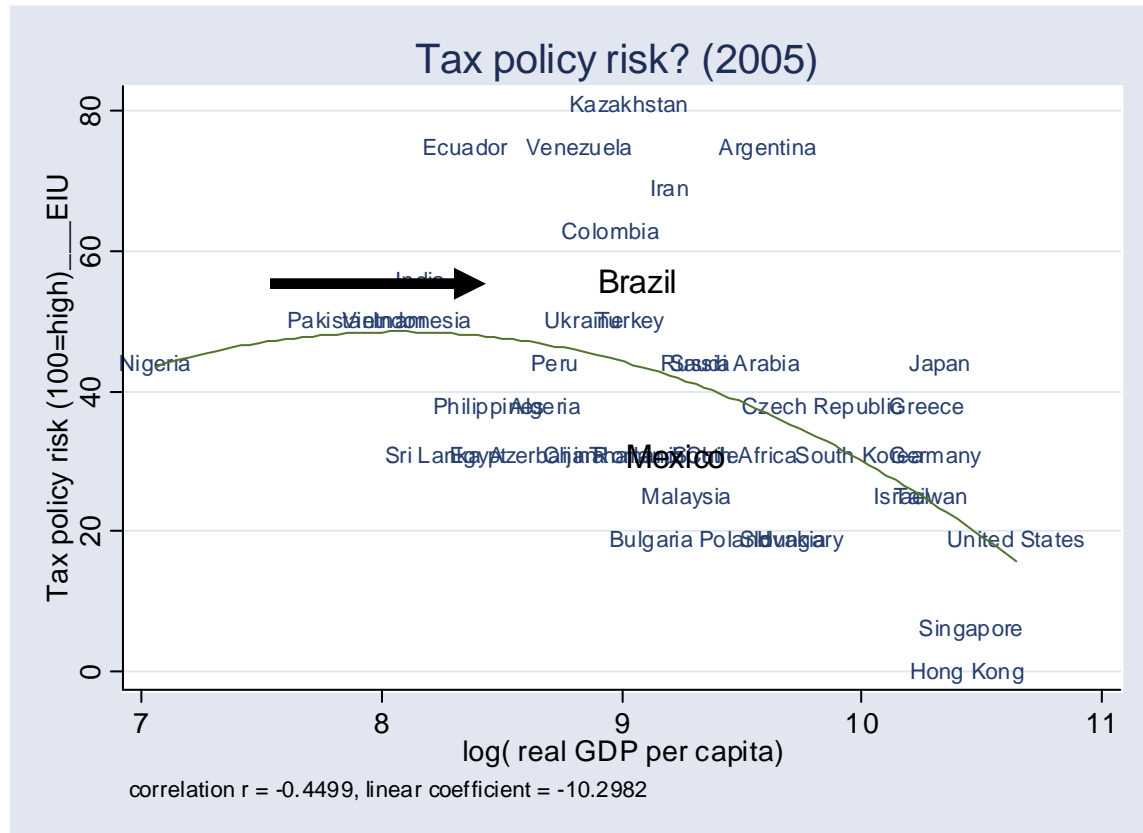
VAT and Income tax rates in Latin America					
Country	VAT		Income Personal		Income Corporate
	Main rate	number of rates	Lowest rate	Highest rate	
Uruguay	23	2	30	30	35
Argentina	21	3	6	35	35
Perú	19	1	15	30	27
Chile	18	1	5	45	16.5
Colombia	16	9	22	38.5	38.5
México	15	2	3	32	34
Bolivia	13	1	13	13	25
Costa Rica	13	1	10	25	36
Brasil	11	3	15	27.5	34
Ecuador	10	1	5	25	36.25
Average	16		12	30	32

Source: World Bank "Colombia Public Expenditure Review", 2002

Note: Adapted from Cubillos et al. 2005.

The constraint may not be the current tax rate, but the perceived risks of this tax rate changing in the future. However, the EIU indicator for tax policy risk in Peru is low, suggesting that appropriability concerns due to taxes are not a binding constraint on growth (Figure 35).

Figure 35.



Source: WDI and EIU.

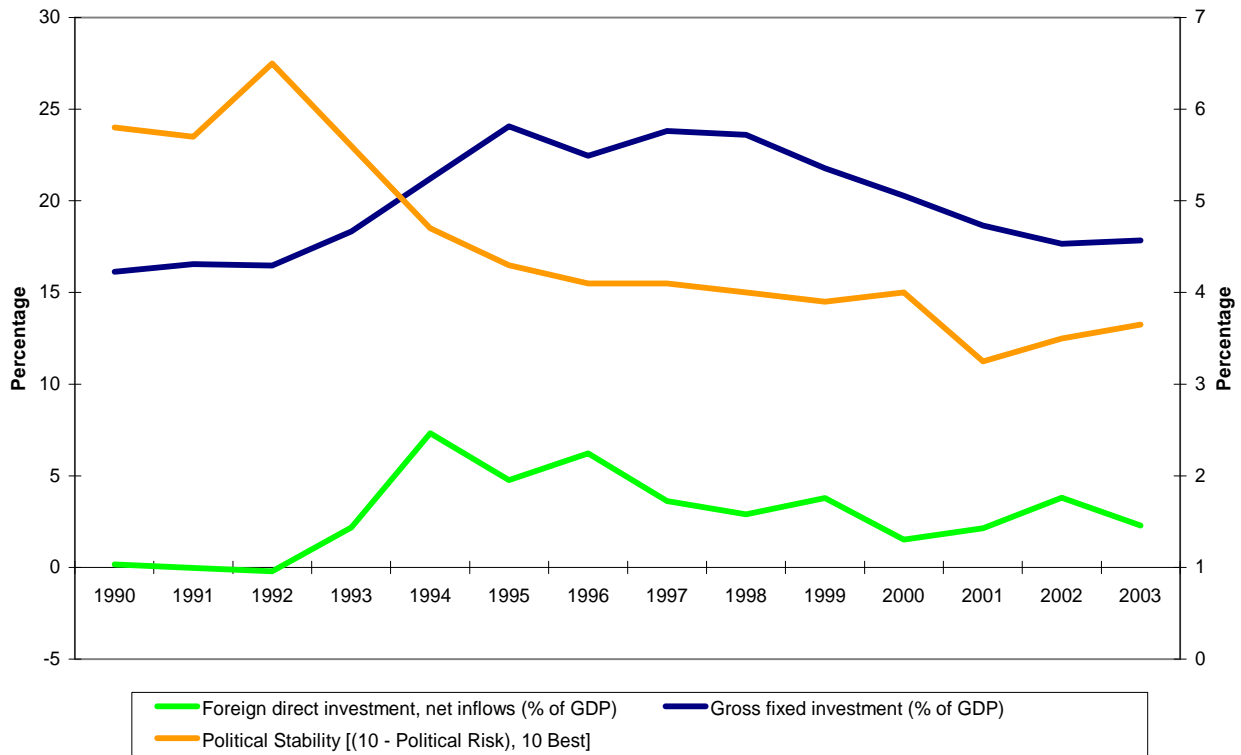
Macroeconomic Risks

The figures discussed above show that, particularly since 2000, macroeconomic volatility has been quite low. Moreover, we see that although perceptions of political risk rose in the 1990s with the events leading to the closure of parliament in 1992 and then to the resignation of Fujimori in 2002, so did foreign investment and overall investment (Figure 36). This is a signal that such changes were not perceived as threatening to economic activity.

Figure 36.

Investment and Political/Government Stability

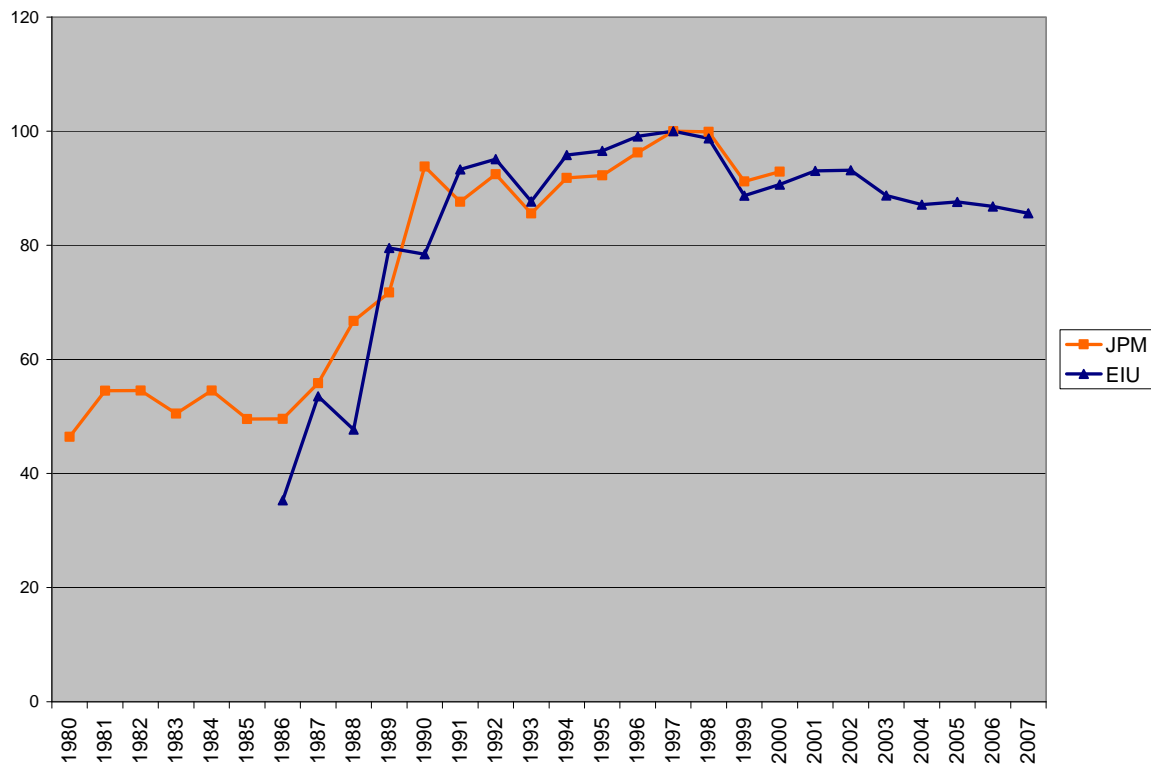
Sources: WDI, EUI, CountryData



Source: Adapted from Cubillos et al. (2005).

One area of concern, however, is the level of the real exchange rate and its effects on the returns to exploring new tradable activities. Unlike infrastructure, which is highly specific to particular activities, the real exchange rate affects all tradable activities. But like infrastructure, the real exchange rate is a potential explanation for the lack of movement to new, nearby export activities. Figure 37 shows that the trend in the real exchange rate was strongly upward in the late 1980s, and has since been stable.

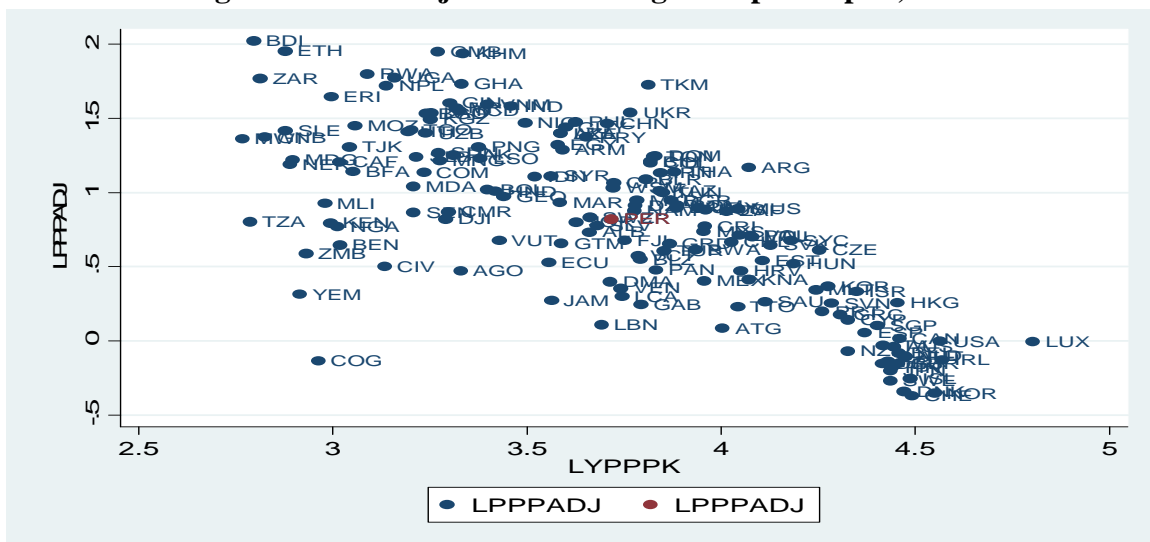
Figure 37. Real Exchange Rate



Source: EIU and JP Morgan.

We use the purchasing power parity (PPP) adjustment as an internationally comparable indicator of the level of the real exchange rate. Peru does not have a weak real exchange rate that would help in the process of discovering new export opportunities, and therefore this may be an area of concern (Figure 38).

Figure 38. PPP Adjustment vs. Log GDP per Capita, 2004

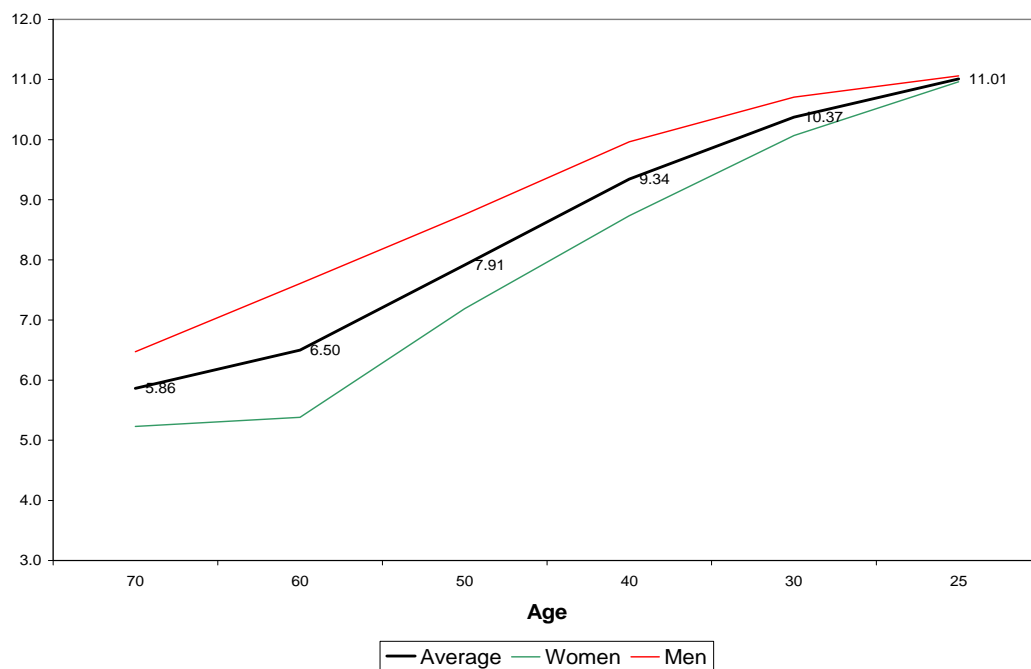


Source: WDI.

Education

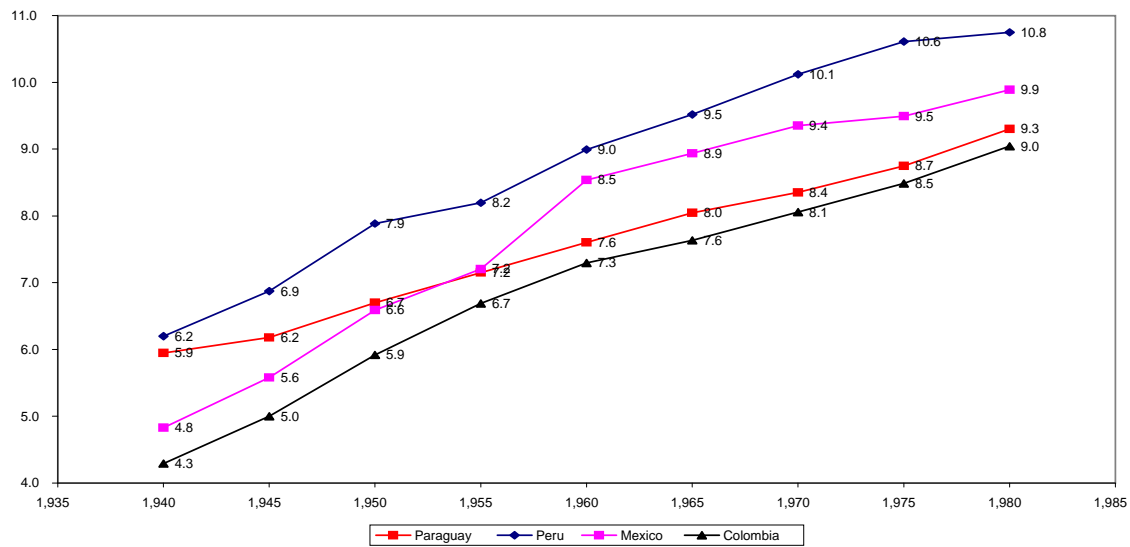
As evidenced by the years of education among Peruvians of different ages, the supply of education among those entering the workforce increased sharply between 1975 and 2005, in the context of a significant growth collapse (Figure 39). Moreover, it is high internationally (Figure 40).

Figure 39. Years of Education by Age, 2000



Source: Encuestas Nacionales de Niveles de Vida.

Figure 40.
Average schooling of cohort by year of birth

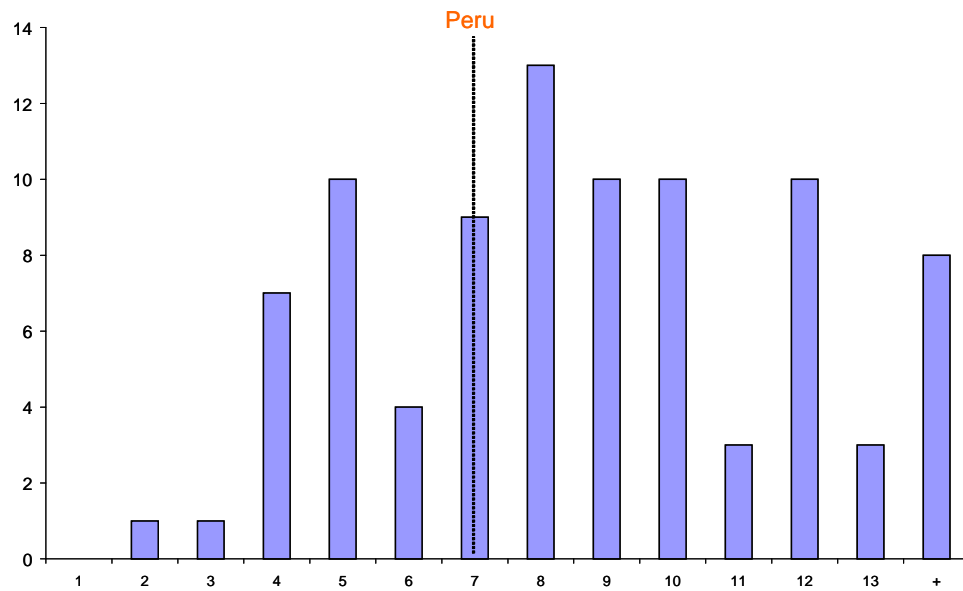


Source: Encuestas Nacionales de Niveles de Vida.

Although the supply has risen, the market “price” of education has not. The returns to education are neither high internationally nor rising significantly (Figure 41). In fact, returns to education for urban males in Peru fell in the second half of the 1990s, and are lower than those of Mexico, Colombia, and Paraguay (Figure 42). This is inconsistent with the fact that the shadow price of a binding constraint should be high and rising. If the supply of skilled workers was binding, firms would be offering them increasingly higher wages. This is not the case in Peru (Figure 43).

Figure 41.

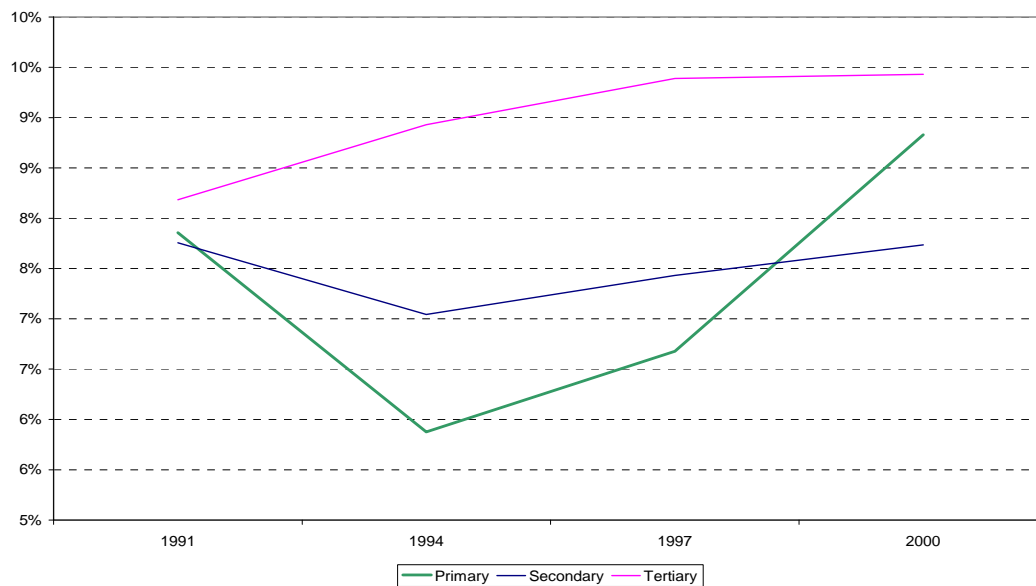
Returns to Education (World Histogram)



Source: Encuestas Nacionales de Niveles de Vida.

Figure 42.

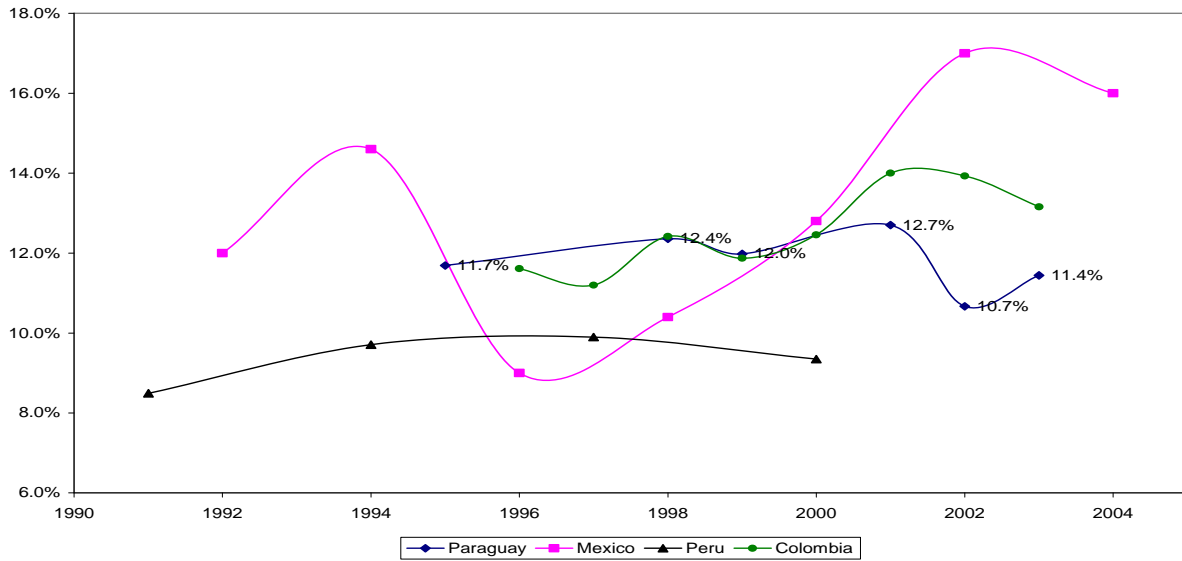
Annual Returns to Education in Peru, By Schooling Level



Source: Encuestas Nacionales de Niveles de Vida.

Figure 43.

Mincerian returns to Education, Urban Males



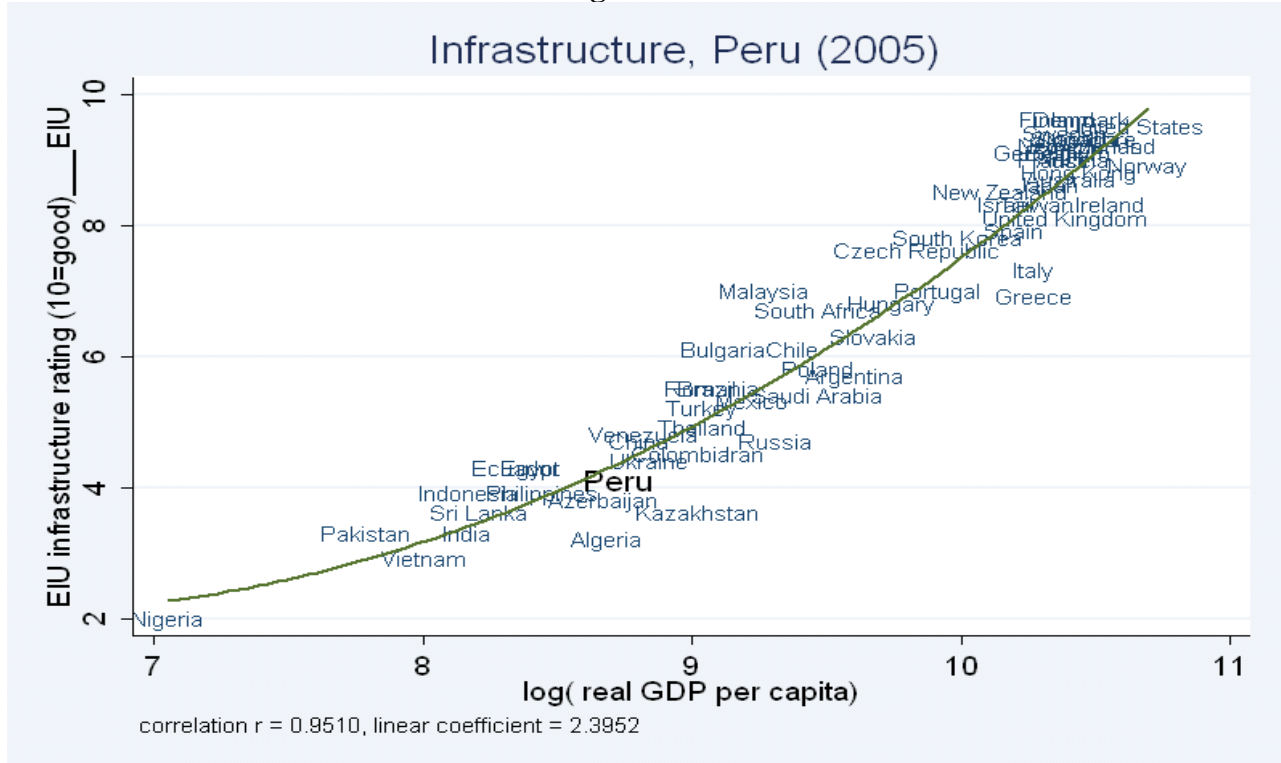
Source: Encuestas Nacionales de Niveles de Vida.

These figures are difficult to reconcile with a hypothesis that the provision of education is a binding constraint on Peru's economic growth.

Infrastructure

What possible role does infrastructure play in the story? In some benchmarks, infrastructure quality does not seem terrible. Given its level of income per capita, Peru's infrastructure quality rating by the EIU is around what would be expected (Figure 44).

Figure 44.



Source: EIU and WDI.

Moreover, in Peru's Investment Climate Assessment, the average ratings for the degree to which telecommunications, electricity, and transportation were a constraint to growth were all less than 1. In other benchmarks, however, Peru fares worse. In the Global Competitiveness Report (2005), Peru is well below the Latin American average in all types of transportation infrastructure (Table 3).

Table 3. Global Competitiveness Report, Infrastructure Ratings

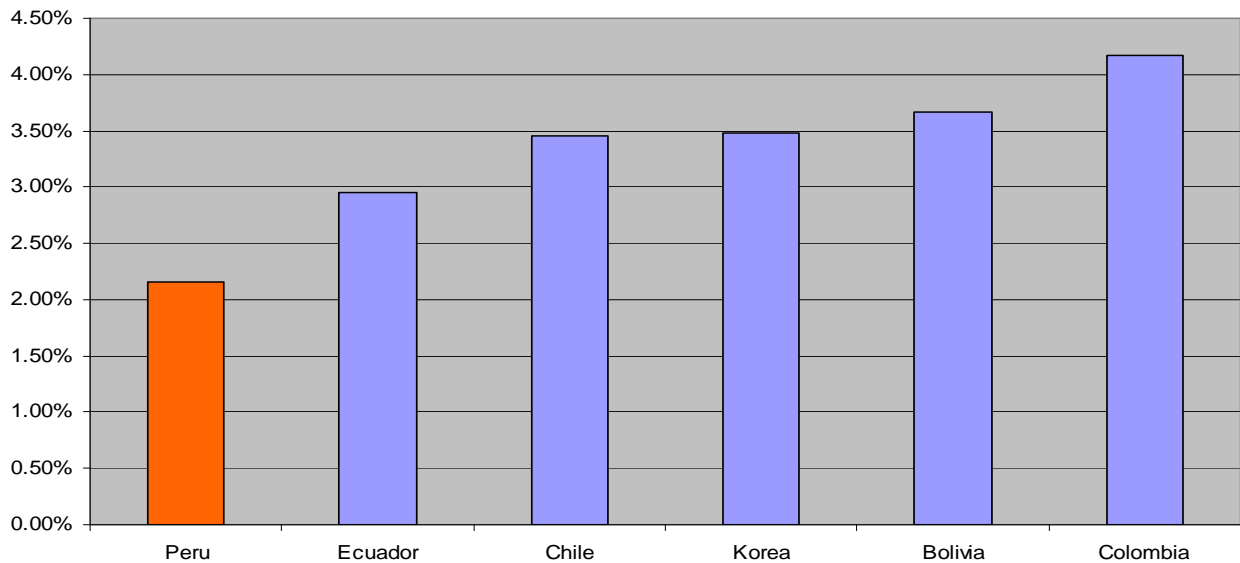
	Rail	Ports	Air Transport
Argentina	2.7	3.6	4.3
Bolivia	1.8	1.	3.7
Brazil	1.8	2.7	4.5
Colombia	1.4	2.8	4.7
Costa Rica	1.2	2.3	4.5
Chile	2.7	4.9	5.7
Dominican Republic	1.1	3.4	4.8
Ecuador	1.2	2.9	4.4
El Salvador	1.5	3.9	5.6
Mexico	2.2	3.3	4.9
Paraguay	1.0	2.3	2.9
Peru	1.6	2.1	3.2
Uruguay	1.5	4.4	3.5
Venezuela	1.3	2.8	4.0
LAC	1.64	3.06	4.34

Note: 1 = underdeveloped, 7 = efficient.

Source: Global Competitiveness Report 2005/6.

Moreover, public investment in Peru is less than 30 percent of its historical peak levels in the 1970s. Although it is true that many areas of investment in the 1975 figures are now in the private sector, public investment in Peru remains low internationally. As a share of GDP, it is less than two-thirds that of Chile and Korea (Figure 45). And this does not capture the deterioration in the public capital stock over the past 30 years.

Figure 45. Public Investment as a Share of GDP, 2001



Note: Data are for 2001 with the exception of Bolivia, which is 1994, and Korea, which is 1997 (the most recent year available). Calculated as central government capital expenditures from IMF Government Financial Statistics divided by GDP from WDI, all in current local currency units (LCU).

This suggests that there might have been a significant reduction in the effective supply of infrastructure as the cumulative amounts seem insufficient to maintain the public capital stock. But most importantly, when considering coordination failure, much of the coordination we mentioned was in determining what sector-specific public goods are required by a particular activity. Infrastructure is a major public good that is highly sector-specific. A clear example is in the gas industry, where pipelines and ports are highly specific and generate few positive spillovers for other activities. The types of infrastructure needed by non-traditional agriculture in terms of roads and logistics is very different from those that would be required by an urban-based manufacturing industry such as automotive, electronics, apparel, or a service outsourcing sector. And even within the non-traditional agriculture sector, requirements are diverse: the type of infrastructure needed for fresh fruit is quite different from that needed for paprika. Therefore, these two constraints, infrastructure and coordination failures, are highly related, as it is sector-specific infrastructure that must be coordinated by the government to allow structural transformation to occur, particularly when there is the need to move to products that are farther away in the product space. Given the limited capacity of the government to provide requisite infrastructure and sector-specific public goods, this may have limited the capacity of the

economy to achieve structural transformation. In this sense, infrastructure and structural transformation may be constraints reflective of a similar underlying problem.

However, the fact that the principal urban agglomeration is next to a port, as opposed to the case of Colombia, Mexico, or South Africa, suggests that the required infrastructure for an urban-based manufacturing process should not have been difficult to achieve. Therefore, the dominant constraints may have been elsewhere.

Policy Implications

Peru's recent growth performance has been impressive, with growth in per capita GDP hovering around 5 percent per year in 2004-2006. But that performance deteriorates as we look back in time. Over the past decade (including 2004-2006), per capita GDP grew at about 2 percent. If we look at the long run, Peru is reaching the levels of GDP per capita it had already achieved in the 1970s. This has happened in spite of massive improvements in human capital, macro stability, and financial markets. Moreover, GDP per capita overstates the improvement in welfare as it has grown much faster than consumption, formal employment, real wages, and national income.

We note that the recent recovery in GDP has been fueled by a recovery in exports that are highly capital-intensive. This is expressed in the fact that in spite of massive growth in mining output, employment in this sector actually declined. Moreover, since much of the invested capital is foreign owned, the income accrues to its owners, limiting its impact on national income. Just as the growth recovery was export-led, the previous collapse between 1979 and 1993 was also export-led. With the exception of non-traditional agriculture, the sectors that collapsed and those that recovered are pretty much the same. Moreover, the mining and gas sectors are trapped in a vicious cycle in which low tax and royalty rates are required to compensate foreign investors for the expropriation risk they perceive, given Peru's history and recent political rumblings. But low tax and royalty rates increase the incentives for the polity to vote for expropriation. The appropriability risk probably also helps explain the growth collapse and its duration. The risk must have discouraged supply in traditional industries, which lost market share, and in structural transformation precisely at the time when the export collapse required the economy to discover new products through which it could integrate in the global economy. Overshadowing the problems of appropriability is the main binding constraint to growth: a lack of discovery of new export activities that are intensive in urban labor. If these activities were identified, the fact that

the global market is so large means that the activities could be scalable and represent significant additions to the demand for labor.

If Peru were to achieve a significantly sized urban-based export sector, the marginal productivity in that sector would determine the dollar wage rate for the country: the higher the productivity of that sector, the greater the standard of living of the labor force, independent of the sector of employment. Ideally the object of policy is to identify potential new areas of export dynamism and provide them with the requisite general and specific public inputs.

This information is not readily available and requires entrepreneurs to risk their capital in finding out. The willingness of entrepreneurs to engage in such an activity depends on the expected returns and their appropriability. In general these activities suffer from coordination and information externalities. Coordination externalities imply a chicken and egg problem in which providers of the required specific non-tradable inputs for new activities are not in place because there is no demand for them. But without these inputs, the activity cannot exist. This is particularly serious for publicly provided inputs (such as specific property rights, regulations, market access rules, infrastructure, etc.), as the government must solve two information problems. First, it does not know what is needed. And second, even if it knew, it is not clear why it would respond to the need or how it would mobilize the required resources.

Since the first best is not attainable, the second best is characterized by distortions or interventions that increase the expected return of these activities. One such variable is the real exchange rate. It acts as a production subsidy on all tradable activities. Hausmann, Hwang, and Rodrik (2006) present a model in which a temporary real depreciation triggers the search for tradable activities with greater productivity and causes faster growth. Rodrik (2007) shows empirically that undervaluation does promote economic growth.

Having said this, it is clear that the real exchange rate is an endogenous variable. Influencing it requires acting on its determinants. In the context of a floating exchange rate with an inflation targeting regime, the real exchange rate will be affected by the balance between fiscal and monetary policy: a tighter fiscal policy means that the required interest rate to achieve the inflation target can be lower and this tends to imply a weaker exchange rate.

Hence, macroeconomic strategy can help. In addition, the empirical evidence suggests that central banks have some degrees of freedom, especially in circumstances in which the domestic currency is not a perfect substitute for the dollar. In this case, the composition of base

money – i.e., whether it is backed by foreign assets or domestic credit – does matter for the level of the exchange rate. As shown by Levy-Yeyati and Sturzenegger (2007), central banks that intervene to prevent appreciation tend to achieve a more competitive exchange rate and this leads to higher growth.

As we mentioned above, the level of the real exchange rate in Peru is not particularly weak for a country at its income level. A strategy to achieve a more competitive rate, compatible with the inflation target, should be part of the country's macro strategy.

Besides the exchange rate, the total cost of labor in terms not only of direct wages but also levies on the wage rate and onerous dismissal procedures may discourage formal employment. This is the kind of employment contract that an exporting firm needs to have. Although in the non-tradable sector the cost of labor can be passed to the consumer, in the tradable sector it limits expected profits.

However, while formal employment is low and declining as a share of total employment, and while this may bind more in the tradable sector, the evidence of the importance of this constraint for Peru is mixed. The overall restrictiveness of the labor market appears to be average, but dismissal costs and social security contributions appear relatively high. Further studies may be required to identify potential reforms in this area.

The real exchange rate and the labor market rules affect activities across the board. But the problems faced by structural transformation may require a more focused and higher dimensional set of interventions. If the obstacle is the inadequate provision of a specific public good, no amount of depreciation will overcome this.

Hence, a second line of action is to develop the capacity of the state to identify and solve potential coordination failures. This requires a form of public-private cooperation that allows for the identification of those obstacles and a system of incentives for the government. It will also require the fiscal space to do so. More importantly, it requires a framework that will make such cooperation legitimate vis a vis the rest of society. The pitfalls to avoid are capture, rent-seeking, and the generalized perception that such a policy constitutes welfare for the rich. Instead, a focus on exports and jobs, especially urban (i.e., not natural resource based) export jobs, should constitute the focus of the cooperation. Hausmann and Rodrik (2006) and Hausmann, Rodrik, and Sabel (2007) provide recommendations in this regard.

The analysis of the product space suggests that nearby products are in non-traditional agriculture, seafood, mining, and food processing. These should be achievable by identifying obstacles and opportunities through dialogue with existing activities. Issues such as transport infrastructure, logistics, sanitary and phyto-sanitary regulation, food safety standards, agricultural research, and international market access negotiations are likely to be relevant.

However, this strategy is unlikely to be sufficient because the position of Peru in the product space does not offer a “stairway to heaven” in terms of structural transformation. Moreover, the nearby products generate few urban jobs where the bulk of the additional labor supply will be concentrated. Small jumps to new sectors that are nearby will not solve the problem: new areas of the product space must be explored. And because they are far away from current production, many of the necessary inputs in terms of property rights, skills, infrastructure, and regulation do not exist.

Therefore, the third priority area for policy is to support strategic jumps by encouraging investors to search for opportunities in Peru. Here a public sector development bank that could act as a public venture capitalist may be quite beneficial.

This would create an entity that would screen the opportunity set of new activities and provide the willingness to socialize parts of the risk. Through its willingness to participate, it would garner the attention of potential entrepreneurs in exploratory activities whose costs need to be discovered. Being part of the public sector means that it could inform the rest of the government when it finds obstacles that could be removed through the adequate provision of public inputs. Fundación Chile is a good example of such an entity. In other settings, the purposeful promotion of particular sectors – such as the electronics cluster in Malaysia and Israel, the tourism industry in Mexico, the automotive industry in Thailand, and the promotion of foreign investment in Ireland – attests to the importance of creating the specific conditions required for particular sectors to operate at world class productivities. Hausmann, Rodrik, and Sabel (2007) propose the use of development lending in order to create interest in this exploration, inform the public sector about opportunities and obstacles, and help coordinate the requisite public inputs.

Finally, the history of nationalization, collapse, and privatization (with highly-generous terms to private investors to compensate for the uncertainty) must be broken. The achievement of a more sustainable property rights regime for foreign investment is required to de-politicize the

issue and create a more secure basis for future investment. Highly generous concessions to foreign firms are not politically sustainable in the longer term, although they were required to regain international confidence. However, unilateral changes to previous agreements will only serve to increase the negative impact of appropriability uncertainty. Therefore, the government should continue to work with this sector to grandfather existing agreements with some marginal gains but to create a more sustainable environment for new investments. These policies are underway and should continue, along with public information efforts to ensure long-term political sustainability.

Appendix

Source Acronyms

BCRP: Banco Central de Reserva del Peru

EIU: Economist Intelligence Unit

IFS: International Monetary Fund, International Financial Statistics

INEI: Instituto Nacional de Estadística e Informática, Peru

Kaufman: World Bank Governance Indicators

WDI: World Bank, World Development Indicators

Technical Details

EXPY

Hausmann, Hwang, and Rodrik (2006) develop a measure of the revealed sophistication for each product, which they call PRODY, as the revealed comparative advantage (RCA)-weighted GDP per capita of each country that exports the good:

$$PRODY_k = \sum_j \frac{(x_{jk}/X_j)}{\sum_j (x_{jk}/X_j)} Y_j$$

where x_{jk} equals exports of good k by country j , X_j equals total exports by country j , and Y_j equals GDP per capita of country j . This is the GDP of the “typical” country specialized in that product. It can be used to measure the sophistication of a country’s entire export basket, which the authors call EXPY. EXPY is simply the PRODY of each good (l) that the country (i) exports, weighted by that good’s share in the country’s export basket (X_i). It represents the income level associated with a country’s export package.

$$EXPY_i = \sum_l \left(\frac{x_{il}}{X_i} \right) PRODY_l$$

Proximity

The measure of proximity is found by first developing a measure of distance between products. We measure the distance between each pair of products based on the probability that countries in the world export both. If two goods need the same capabilities, this should show up in a higher probability of a country having comparative advantage in both. Formally, the inverse measure of distance between goods i and j in year t , which we call proximity, equals

$$\varphi_{i,j,t} = \min\{P(x_{i,t} | x_{j,t}), P(x_{j,t} | x_{i,t})\}$$

where for any country c

$$x_{i,c,t} = \begin{cases} 1 & \text{if } RCA_{i,c,t} > 1 \\ 0 & \text{otherwise} \end{cases}$$

and where the conditional probability is calculated using all countries in year t . This is calculated using disaggregated export data across a large sample of countries from the World Trade Flows data from Feenstra et. al. (2005) and UN COMTRADE.

Density and Open Forest

To measure what is nearby, we must use the pairwise measures of distance defined above to calculate the distance of every product from a country's export basket as a whole. We call this measure density. It is the distance of good i from country c 's export basket at time t . It is the sum of all paths leading to the product in which the country is present, scaled by the total number of paths leading to that product. As with proximity, we define x based on whether the country has revealed comparative advantage in the product (if $RCA \geq 1$). Density varies from 0 to 1, with higher values indicating that the country has achieved comparative advantage in many nearby products, and therefore should be more likely to export that good in the future.

$$density_{i,c,t} = \left(\frac{\sum_k \varphi_{i,k,t} x_{c,k,t}}{\sum_k \varphi_{i,k,t}} \right)$$

Density is a key variable in the process of growth diagnostics: it can be taken as an indicator of the degree of coordination needed to produce any given product. If the product is very near the current export basket, density will be high, meaning that most of the capabilities needed in the new sector will already exist in other sectors. However, if density is low, then the human capital, physical capital, property rights, infrastructure, and every other sector-specific factor of production that the sector needs will not exist, and cannot be easily adapted from what does exist.

To measure whether a lack of coordination was holding back structural transformation in Peru, we can use density to determine if there were many nearby opportunities for structural transformation available to Peru after the terms of trade shock. We check whether the country did not capitalize on these because of some other constraint, or if there were simply no nearby products that could fuel structural transformation in the absence of coordination.

To do this, we need to use density, which is at the country/product level, to measure the opportunity set for the country as a whole. This measure, called “open forest,” answers the question: “How green is your valley?” Density measures the extent to which the current export basket is well-connected to other new and valuable opportunities for structural transformation. It is calculated as follows:

$$open_forest_{c,t} = \sum_i \sum_j \left[\frac{\varphi_{i,j,t}}{\sum_i \varphi_{i,j,t}} (1 - x_{c,j,t}) x_{c,i,t} PRODY_{j,t} \right]$$

References

- Arrow, K. 1962. "The Economic Implications of Learning by Doing." *Review of Economic Studies* 29(3): 155-73.
- Bardhan, P. 1970. *Economic Growth, Development, and Foreign Trade*. New York: Wiley-Interscience.
- Braun, M., and C. Serra. 2006. "Understanding Economic Growth in Peru 1970-2005: The Financial Sector." Center for International Development / CAF workshop. November 16, 2006, Cambridge MA.
- Calvo, G., A Izquierdo and E. Talvi. 2006. "Sudden Stops and Phoenix Miracles in Emerging Markets." *American Economic Review* 96(2): 405-410.
- Cubillos, N., C. Hazlett, and M. Lopez-Silva. 2005 "Growth Diagnostics: The Case of Peru." Presented in PED309, November 4, 2005. Kennedy School of Government, Harvard University.
- Feenstra, R., R. Lipsey, H. Deng, A. Ma, and H. Mo. 2005. "World Trade Flows: 1962-2000." NBER working paper 11040. National Bureau of Economic Research, Cambridge MA.
- Hausmann, R., J. Hwang, and D. Rodrik. 2006. "What You Export Matters." Working Paper #11905. Cambridge, MA: National Bureau of Economic Research.
- Hausmann, R., and B. Klinger. 2006. "Structural Transformation and Patterns of Comparative Advantage in the Product Space." Harvard University Center for International Development Working Paper #128.
- Hausmann, R., and B. Klinger. 2007. "The Structure of the Product Space and the Evolution of Comparative Advantage." Harvard University Center for International Development Working Paper #146 (extended and revised version of #128).
- Hausmann, R., F. Rodriguez, and R. Wagner. 2006. "Growth Collapses." Harvard Center for International Development Working Paper #136. Cambridge, MA.
- Hausmann, R., and D. Rodrik. 2003. "Economic Development as Self-discovery." *Journal of Development Economics* 72: 603-33.
- Hausmann, R., and D. Rodrik. 2006. "Doomed to Choose: Industrial Policy as a Predicament." Center for International Development Blue Sky Conference Paper, September 2006.
- Hausmann, R., D. Rodrik, and C. Sabel 2007 "Reconfiguring Industrial Policy." Center for International Development, Harvard University.

- Hausmann, R., D. Rodrik, and A. Velasco. 2004. "Growth Diagnostics." Center for International Development, Harvard University.
- Heckman, J., and C. Pages. 2003. "Law and Employment: Lessons from Latin America and the Caribbean." NBER Working Paper 10129. Cambridge, MA.
- Hidalgo, C., B. Klinger, A.-L. Barabasi, and R. Hausmann. Forthcoming. "The Product Space and Its Consequences for Economic Growth." *Science Magazine*.
- Hwang, J. 2007. "Introduction of New Goods, Convergence and Growth." Department of Economics, Harvard University, mimeo.
- Jaffe, A. 1986. "Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Value." *American Economic Review* 76(5): 984-1001.
- Klinger, B. 2007. "Uncertainty in the Search for New Exports." Harvard Center for International Development Graduate Student and Postdoctoral Fellow Working Paper #16.
- Leamer, Edward E. 1984. *Sources of Comparative Advantage: Theory and Evidence*. Cambridge MA: The MIT Press.
- Levy-Yeyati, E., and F. Sturzenegger. 2007. "Fear of Appreciation." Policy Research Working Paper 4387. Washington, DC, United States: World Bank.
- Maddison, A. 2007. "World Population, GDP and per Capita GDP 1-2003 AD." Groningen, The Netherlands: University of Groningen, Groningen Growth and Development Centre. Available at: <http://www.ggdc.net/maddison/>
- Rodrik, D. 2007. "The Real Exchange Rate and Economic Growth." Cambridge, United States: Harvard University, Kennedy School of Government. Mimeographed document. <http://ksghome.harvard.edu/~drodrik/RER%20and%20growth.pdf>
- World Bank. 2005. *World Development Indicators*. Washington, D.C.: World Bank.