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An Overview

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Abstract[*]

The effectiveness of exchange rate adjustments depends critically on the extent to which depreciations "pass through" to inflation, an effect that is known as exchange rate pass-through (ERPT). In particular, if an exchange rate depreciation does not result in a lasting change in relative prices, namely a real depreciation, it will not provide the desirable competitiveness gains. This paper looks at the question of pass-through and its determinants for the group of countries whose central banks are members of the Financial Stability and Development (FSD) network. All of these countries experienced large terms of trade shocks and large depreciations in the past couple of years. The findings are that ERPT in the FSD countries is moderate and has become lower over time, in line with the international experience. The pass-through moderation has benefitted from the adoption of floating exchange rates and especially an increase in monetary policy credibility. Despite the relatively lower ERPT in the past two decades, the exchange rate continues to be a large determinant of inflation in several countries.

JEL classifications: E31, E44, E50, F31, F41
Keywords: Exchange rate pass-through, Inflation, Depreciation

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1. Introduction

Countries in South America have experienced large exchange rate volatility over the past two or three years as a result of changing international conditions that put pressure on their external positions. In particular, the decline in the international price of many commodities that are the core of the export base of this group of countries, the uncertain prospects for global economic growth—and China's economic future in particular—and current and prospective increases in risk premiums in international financial markets have all been factors behind significant depreciations in nominal exchange rates.

There are, however, some doubts about the effectiveness of depreciations in increasing exports or improving the trade balance on the whole. Some of those concerns involve the responsiveness of exports, especially of manufactures or differentiated products more generally. These products have not suffered from the price declines that most commodity exports have experienced. Moreover, the market structure for these products is such that they are open to significant market share gains thanks to lower costs of production. However, a sizable expansion in this sector may require substantial investments and some time to materialize and has so far displayed only a limited response.

More importantly, much of the concern about the effectiveness of exchange rate adjustments surrounds the question of whether the depreciation is going to translate into a real depreciation and provide the competitiveness gains required for the investment process to develop. This is not an obvious result from large nominal depreciations in the Latin American experience, especially during periods of high and persistent inflation. As recently as 2014, Argentina attempted to correct its exchange rate overvaluation through a step devaluation of 25 percent, which accelerated inflation to levels around 40 percent on an annual basis, and domestic prices caught up with the exchange rate in about nine months.

The size of the exchange rate pass-through (ERPT) is also a key input for central banks' decisions on monetary policy. Central banks pursuing an inflation targeting framework need to form a view on future inflation and need to know the extent to which they have to offset inflation pressures arising from the depreciation. This is in fact a delicate decision, as central banks would want to avoid generating a contractionary shock in a situation where the international forces have turned negative, while at the same time preserving or strengthening their credibility that is crucial to a successful real exchange rate adjustment.

This paper looks at the question of pass-through and effectiveness of depreciations for the group of countries whose central banks are members of the Financial Stability and Development (FSD) network.[1] All of these countries have experienced large terms of trade shocks and large depreciations in the past couple of years. The findings are that exchange rate pass-through in the FSD countries is moderate and has become lower over time, in line with the international experience reported in the literature. An inspection of the data indicates that the pass-through has benefitted from the adoption of floating exchange rates and especially an increase in monetary policy credibility. The gains in credibility in recent years have accompanied the success of floating exchange rate/inflation targeting systems. The econometric estimates indicate that after an exchange rate shock the pass-through to the general price level is 14 percent up to one year and 20 percent over a two-year time horizon. For traded goods, the average estimates are 18 and 26 percent, respectively. However, we find that despite the relatively lower ERPT in the past two decades, the exchange rate continues to be a large determinant of inflation in several countries.

The paper is organized as follows. Section 2 explores the channels through which a currency depreciation spreads to domestic prices, and makes a distinction between the direct effects on prices of imported and exported goods, where the size of the pass-through, on the one side, relates to microeconomic factors like market structures and business strategies; and the indirect effects on prices of other goods—included nontraded goods—where macroeconomic factors such as inflation expectations and wage setting frameworks play a significant role, on the other side. In Section 3, the paper looks at some stylized facts about pass-through in the FSD group countries, and finds that monetary policy credibility is a key factor explaining the degree of pass-through and its evolution. In Section 4 the paper estimates the size of pass-through for FSD countries using VAR models, which permits us to disentangle different types of shocks more precisely.

2. The Channels and Implications

The most direct, and most studied, channel through which exchange rate changes are reflected in domestic prices is the direct effect on import prices, or more generally the prices of all traded goods. The direct effect operates fully when the products are priced in a foreign currency, say the US dollar, and this price is not affected by the exchange rate of the importing country. Thus, a

[1] Currently, Argentina, Brazil, Chile, Colombia Paraguay, Peru and Uruguay are full members of the FSD group.

depreciation of the local currency would result in a proportional increase in the price of imported goods, resulting in a pass-through of 100 percent "at the border." It should be noted that, as the product moves through the distribution system, the value added to it is largely not affected by the exchange rate, implying that the price increase at the retail level will be much less than at the border. Given the relative importance of distribution services like transportation, storage and retail trade, the pass-through as reflected in the Consumer Price Index (CPI) should be expected to be significantly lower than 100 percent. Similarly, in the case of imported inputs, exchange rate changes will be reflected only to the extent of their share in the overall cost of production of final goods. In the case of exports, a similar mechanism operates. If the exporter sets the price of its product in US dollars in line with international markets, the local currency price will be increased by the full extent of the exchange rate depreciation and the same price increase will be applied in domestic markets. Once again, the costs involved in the distribution services will in principle not be affected and will muffle the impact on the CPI. For simplicity, we will discuss the case of pass-through to import prices in what follows, although an entirely analogous case can be built for the case of export products.

The baseline case of 100 percent pass-through at the border has been questioned both empirically and conceptually. In the case of homogenous goods and an integrated world market, such as commodities, one would expect that the international price in US dollars would not change and there would be full pass-through of exchange rate changes. In the case of differentiated, manufactured goods, the literature observes that local currency pricing or "pricing to market" applies at least to some degree. This is a situation in which the exporter keeps the price in the local market more or less unchanged or at least does not fully reflect the exchange rate. The degree of pass-through would depend on the extent of differentiation between the imported good and its domestic alternatives, on the existence of market segmentation, and on the structure of the cost function of the local producer firms that have an opportunity to increase their market share (see Aron, Macdonald and Muellabuer, 2014; Campa and Goldberg, 2005; and Burstein and Gopinath, 2014). Price stickiness, owing to "menu costs" involved in changing prices also affect the speed with which exporters change prices and the degree of pass-through at different time horizons. The exporter may face costs of changing prices, may not want to present its customers with frequent price changes or may not think that the exchange rate movement is long lasting.

One interesting approach to understanding the degree of pass-through at the border is to focus on the currency of invoicing in international trade. The empirical regularity is that prices tend to be fairly stable in the currency of invoicing. A plausible explanation is that firms chose a currency that is stable and has low inflation in order to minimize price changes and associated menu costs. The vast majority of prices in international trade are invoiced in US dollars or Euros. Kamps (2006) estimates that for European countries, over 90 percent of international trade prices are denominated in one of these two currencies. Although Latin American countries are not included in that study, East Asian economies also have a share of almost 80 percent of trade prices denominated in either US dollars or Euros. Currency of denomination is closely associated with exchange rate pass-through into import prices. This is illustrated by the fact that pass-through into import prices is over 90 percent for Turkey and over 80 percent for Japan but less than 40 percent for the United States, in line with the currency of invoicing in international trade (Gopinath, 2015).

In addition to these microeconomic stories, it has been argued that an environment of low and stable inflation contributes to a lower pass-through rate (Taylor, 2000). Lower and more stable inflation results in less persistent inflation, and this feeds into firms' price-setting behavior and results in lower pass-through. The story is also consistent with the observation that exchange rate pass-through is higher in emerging market economies (where policy credibility is sometimes a persistent problem) than in advanced ones (Calvo and Reinhart, 2001). Furthermore, exchange rate expectations may propagate through collecting bargaining agreements, implying that a depreciation can be directly passed through to prices of both traded and nontraded goods.

In the FSD countries, macroeconomic factors probably are crucial. Given the dominant foreign currency invoicing and small domestic markets, it is likely that pass-through at the border is quite high. The spread of this effect to overall prices will depend heavily on the degree of openness of the economy, monetary policy, credibility, the extent of indexation, and expectations.

An important implication is that micro and macro channels of ERPT have somewhat different implications for the effectiveness of depreciations in improving the external balance position. The microeconomic factors imply that a high level of pass-through makes exchange rate depreciations *more* effective because they create a competitive advantage for domestic producers that can gain market share at the expense of imports. By contrast, a higher level of

pass-through owing to macroeconomic factors makes exchange rate depreciations *less* effective because it results in higher increases in the prices of nontraded goods and wages and frustrates any gain in competitiveness brought about by the exchange rate change.

3. Pass-through in FSD Countries

Measuring pass-through, or in fact defining pass-through, involves some challenges. The challenges are at least three: the relevant time span, the relevant measure of inflation and the relevant measure of the exchange rate. Choices made with respect to these questions reflect not only empirical strategies but also the type of story that motivates the study: a micro story that tries to measure competitiveness in domestic markets or a macro story where the concern is with the effectiveness of exchange rate adjustments and monetary stability.

Broadly speaking, most studies have focused both on short term pass-through (anywhere from one month up to one year) and long-term pass-through, when the horizon exceeds one year. This choice is probably based mostly on what empirical results suggest in terms of detecting an effect. As to the measure of inflation, the choice is basically between trade prices (imports, usually, but sometimes also exports) or the aggregate consumer price index. If the main reason to investigate pass-through is the impact of exchange rates on firms' decisions on market share and markups, the variable of interest would be import or export prices, but when the focus is on the viability and effectiveness of the monetary system, then the variable of interest should be an aggregate price index like the CPI. Finally, there is the issue of whether the variable of interest should be the bilateral exchange rate with respect to the US dollar or a multilateral, trade-weighted exchange rate measure. While a focus on competitiveness would suggest using a multilateral measure, there is broad evidence that most international trade transactions are denominated in US dollars, both for commodities and differentiated products, and that prices in US dollars are relatively sticky with respect to exchange rate changes. From a macroeconomic perspective, in addition to the previous considerations, the question hangs on which exchange rate measure has the largest impact on inflation expectations.

Table 1 summarizes a survey of some 25 empirical studies and highlights the following features: the dependent variable of focus (aggregate consumer price index, import or export prices, for example), the countries included in the study, the time horizon of the estimation, and the main estimated values for the pass-through coefficient. The estimates span a wide range, but

it is clear that studies using more recent samples generally estimate lower pass-through effects than in earlier samples. Overall, for the CPI the mean value of estimates is about 16 percent in the short term and about twice as high in the longer run. In the case of imports and exports, the estimated pass-through is significantly higher, reaching about 47 percent in the short run and 53 percent in the longer run. Moreover, the studies estimate higher values of exchange rate pass-through in the case of emerging or developing countries compared to samples of advanced economies, and higher values in cases of large depreciations compared to the impact estimated for an overall sample.

Table 1. Empirical Pass-through Studies: A Summary

Authors	Sample	Estimated Pass-through*
Dependent Variable: CPI		
Akofio-Sowah (2009)	1980-2005 15 Sub-Saharan and 12 Latin American	SSA:12-38% ST LA: 4-19% ST
Borensztein and De Gregorio (1999)	1970-1996 41 large depreciation episodes	26-35% ST 43-48% LT
Caselli and Roitman (2016)	28 emerging economies	1% ST, 22-25% LT Dep >10%: 40% ST, 57% LT Dep>20%: 44% ST, 45% LT
Ca'Zorzi et al. (2007)	1975Q1-2004Q1 12 EM and G3	EM: 24-48% LT G3: 1-13% LT
Choudhri and Hakura (2006)	1979-2000 71 countries	Advanced: 12% ST, 20-23% LT Developing and Emerging: 14/15% ST, 24-27% LT
Coulibaly and Kempf (2010)	1989Q1-2009Q1 27 emerging economies: 15 inflation target (IT), 12 no-IT	IT: 8.2-10.3% ST, 23-29% LT No-IT: 0-1% ST, 5 -35% LT
Frankel et al. (2012)	1990-2002 76 countries	Advanced: 2% LT Developing countries: 34% LT
Gagnon and Ihrig (2004)	1971-2000 20 industrial countries	23% LT
Goldfajn and Werlang (2000)	1980-1998 71 countries	Advanced: 25% ST, 61% LT Developing: 34% ST, 51% LT Emerging: 39% ST, 91% LT
Ihrig et al. (2006)	1975Q1-2004Q4 G7	1975-1989: 13.4% LT 1990-2004: 0% LT
Kohlscheen (2010)	8 emerging economies	5-24% ST
Razafimahefa (2012)	1985Q1-2008Q2 Sub-Saharan countries	20% ST 41% LT

Table 1, continued

Authors	Sample	Estimated Pass-through*
Dependent Variable: Import Prices		
Barhoumi (2006)	1980-2003 24 developing countries	51% ST 64-83% LT
Brun-Aguerre et al. (2012)	1980Q1-2009Q3 37 countries (19 advanced and 18 EM)	Advanced: 56-60% ST, 47-100% LT EM: 60-61% ST, 63-100% LT
Bussière and Peltonen (2008)	1990Q1-2006Q2 41 countries (13 advanced and 28 EM)	35% ST Advanced: 35% ST EM: 35% ST
Campa and Goldberg (2005)	1975-2003 23 OECD	46% ST 64% LT
Ca'Zorzi et al. (2007)	1975Q1-2004Q1 12 EM and G3	G3: 24-114% LT EM: 78-104% LT
Choudhri and Hakura (2012)	1979-2010 34 countries (18 advanced and 16 EM)	57% ST Advanced: 60% ST EM: 54% ST
Coulibaly and Kempf (2010)	1989Q1-2009Q1 27 emerging economies (15 IT, 12 no-IT)	IT: 15-57.5% ST, 13-58% LT Non-IT: 18-36% ST, 20-35% LT
Frankel et al. (2012)	1990-2002 76 countries	Advanced: 13% LT EM: 37% LT
Ihrig et al. (2006)	1975Q1-2004Q4 G7	1975-1989: 71.5% LT 1990-2004: 47.5% LT
IMF (2015)	1980-2014 60 countries (23 advanced and 37 EMDE)	55-61% LT
Dependent Variable: Export Prices		
Bussière and Peltonen (2008)	1990Q1-2006Q2 41 countries (13 advanced and 28 EM)	33% ST Advanced: 22% ST EM: 34% ST
Choudhri and Hakura (2012)	1979-2010 34 countries (18 advanced and 16 EM)	40% ST Advanced: 39% ST EM: 51% ST
IMF (2015)	1980-2014 60 countries (23 advanced and 37 EMDE)	45-62% LT

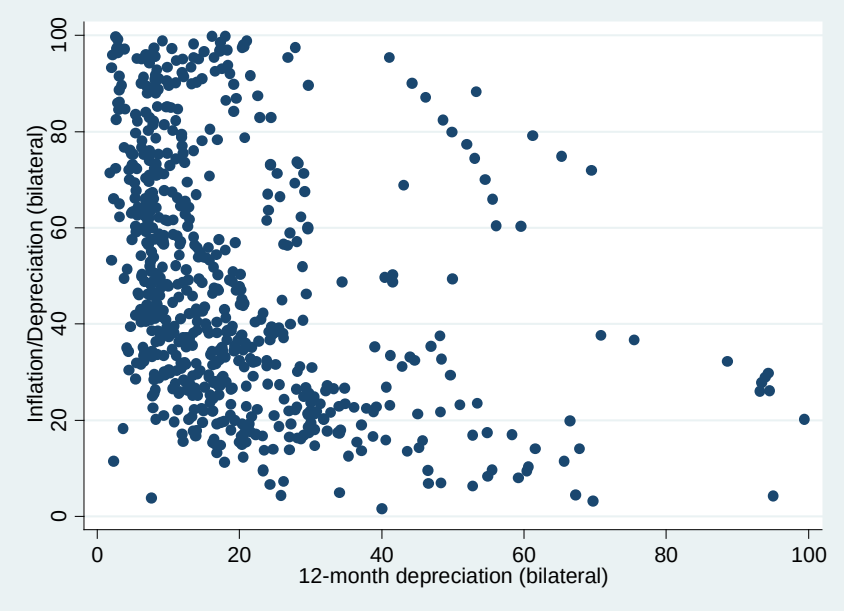
*ST: short term (under one year), LT: long term (over one year).

In what follows, we focus on the seven members of the FSD group, and a sample starting in 1992. The definition of pass-through used for stylized facts analysis consists of the ratio of 12-month inflation to 12-month depreciation, and uses the bilateral exchange rate with the US dollar as the baseline case. Later, we also use multilateral, traded-weighted exchange rates for robustness. We focus on the impact on the consumer price index, with the understanding that macroeconomic factors are critical for the effectiveness of monetary policy in the region, and

that given the predominance of raw materials and foreign currency invoicing in international trade, along with the relatively poor substitutability of imported differentiated goods, pass-through "at the border" is not an interesting question.

Figure 1 displays the exchange rate pass-through—defined as above—against the rate of depreciation for every 12-month period since 1992. We have omitted observations with pass-through higher than 100 percent, which occur at very low levels of depreciation of the currency. It is apparent from the figure that at low levels of depreciation, this simple measure of pass-through tends to be quite high. This may not be very meaningful, however, since what is happening is probably that when the change in the exchange rate is near zero, any normal, moderate level of inflation would appear like a huge pass-through rate. We also excluded cases where the inflation rate was higher than 50 percent, since price and exchange dynamics tend to be more complicated at such rapid rates of growth, and our simple measure of pass-through may not be adequate.

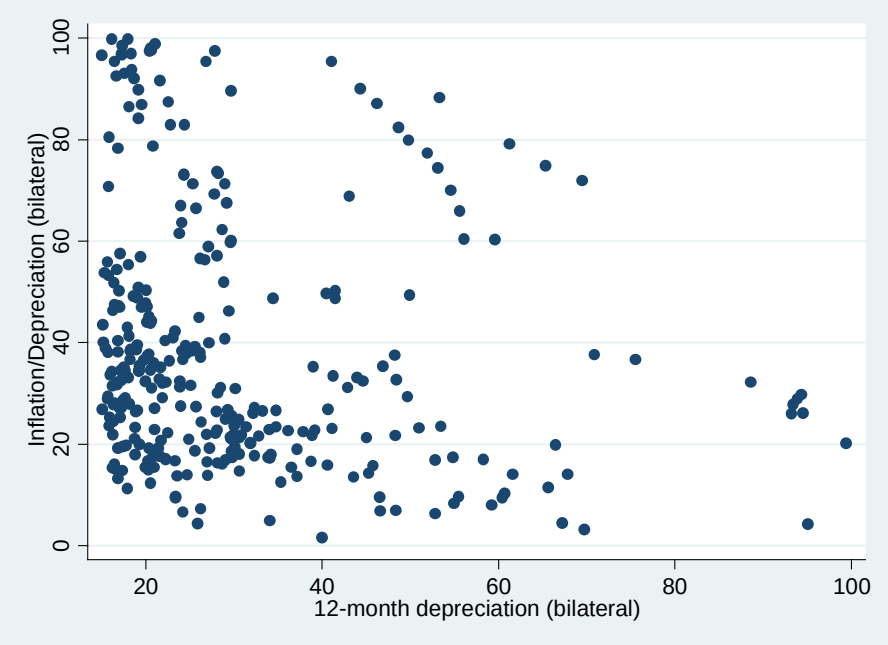
Figure 1. Pass-through at Different Levels of Exchange Rate Depreciation (Bilateral)



Note: Monthly data since January 1992 for Argentina, Brazil, Chile, Colombia, Paraguay, Peru and Uruguay. Restricted to inflation<50%, pass-through between 0% and 100%, and depreciation between 0% and 100%.

In view of the distortions that take place at low depreciation rates, we discard all observations corresponding to depreciation rates below 15 percent and plot the remaining ones in Figure 2. The mean pass-through rate is 38.7 percent, and the median is 31.9 percent.

Figure 2. Pass-through for Depreciations Larger than 15 Percent



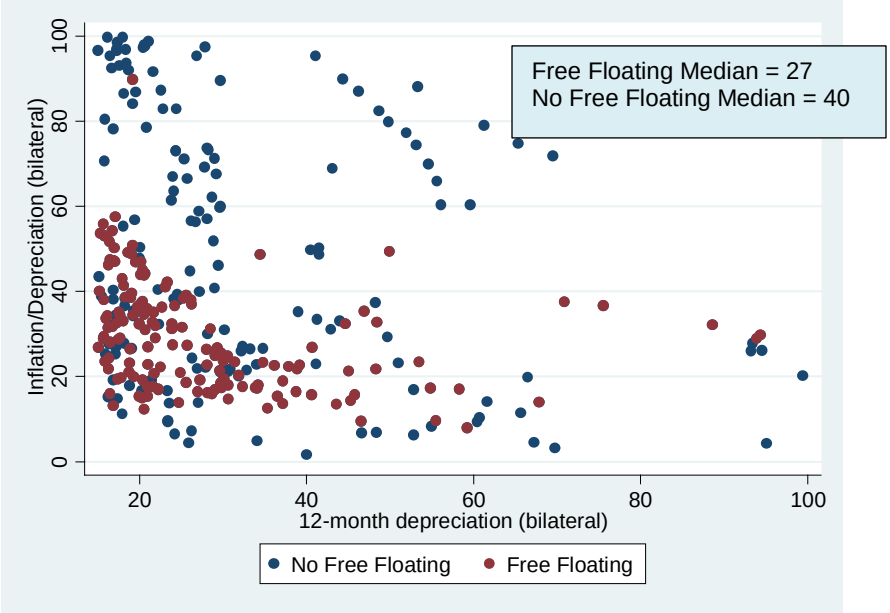
Note: Monthly data since January 1992 for Argentina, Brazil, Chile, Colombia, Paraguay, Peru and Uruguay. Restricted to inflation<50%, pass-through between 0% and 100%, and depreciation between 15% and 100%.

The exchange rate system may affect the degree of exchange rate pass-through. Most countries in the group have moved to a floating exchange rate system since the late 1990s.[2] Floating rates—by definition—are more volatile in nominal terms and may affect inflation expectations and price and wage setting patterns. However, most countries adopted an inflation targeting framework in conjunction with floating the exchange rate and gained credibility with markets fairly rapidly. Thus, the net effect of a floating exchange rate system is not, in principle,

[2] Brazil floated the exchange rate in January 1999 after an unsuccessful defense of a narrow crawling band; Chile went into floating later in 1999 after a *successful* but costly defense of a crawling band in the context of the global sudden stop; at about the same time, Colombia abandoned its crawling band, under exchange rate pressures and widening current account deficits. These three countries adopted inflation targeting regimes at about the same time as they started to float and avoided a return to higher inflation rates of the past although there was some increase in inflation of varying degree, at least initially. Peru, Uruguay, and Paraguay also adopted floating regimes and more recently, by end-2015, Argentina also followed suit.

obvious. In Figure 3, we distinguish observations that correspond to periods of floating rates from all other currency regimes. The data show that pass-through rates are in fact lower under floating exchange rates, with a median of 27 percent, compared to 40 percent under other regimes.

Figure 3. Pass-through under Floating Exchange Rates



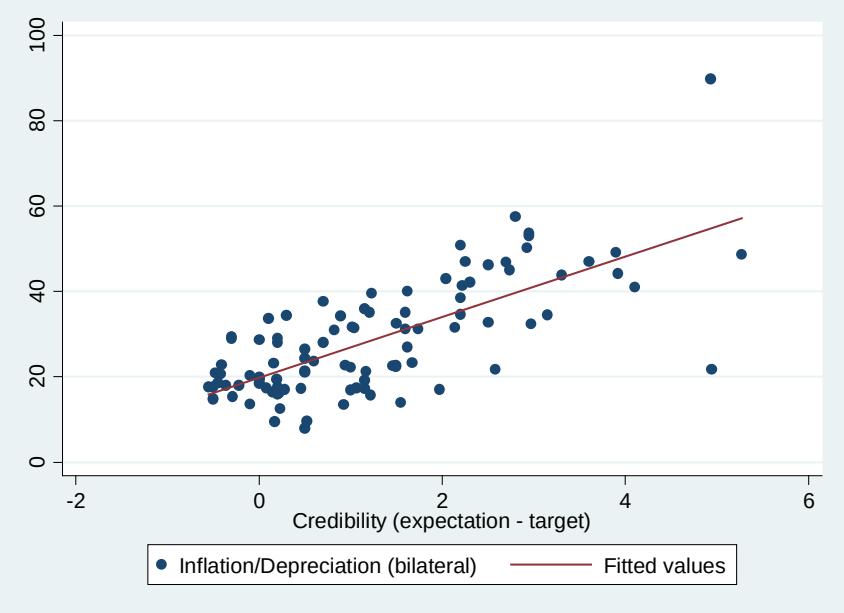
Note: Monthly data since January 1992 for Argentina, Brazil, Chile, Colombia, Paraguay, Peru and Uruguay. Restricted to inflation<50%, pass-through between 0% and 100%, and depreciation between 15% and 100%.

This suggests that monetary policy credibility may have an impact on the exchange rate pass-through. The FSD countries generally adopted inflation targeting frameworks at the time they floated the exchange rate. If the target enjoyed market credibility, the predominant expectation would have been that the central bank would offset any inflationary pressure through a tightening of monetary policy and this belief would dampen inflation expectations and the pass-through to prices itself. To explore this conjecture, we defined monetary policy credibility as the difference between expected inflation (as measured in central bank surveys) and the target for inflation (the center of the band).[3] Figure 4 plots exchange rate pass-through and (lack of) credibility thus defined and finds a statistically significant relation. Roughly speaking, when

[3] Expectations are taken according to the central bank policy horizon.

expectations exceed the target by two percentage points of annual inflation, the pass-through rate increases by about 14 percentage points.

Figure 4. Monetary Policy Credibility and Pass-through



Note: Because of data availability, the figure includes monthly data for Brazil since 2001:12, Chile since 2007:01, Colombia since 2003:10, Uruguay since 2008:01; and annual data for Paraguay since 2011:12 and Peru since 2002:12. Argentina is not included.

The fact that credibility and inflation expectations appear to be relevant for the degree of exchange rate pass-through suggests that macroeconomic channels are important in the determination of the pass-through. To explore this further, we compute the pass-through to traded goods and non-traded goods inflation separately, using measures published by most central banks.[4] Table 2 indicates that the pass-through is similar for both types of goods, reinforcing the idea that macroeconomic channels are important in these countries.

Table 2. Pass-through to Traded and Non-traded Goods Prices

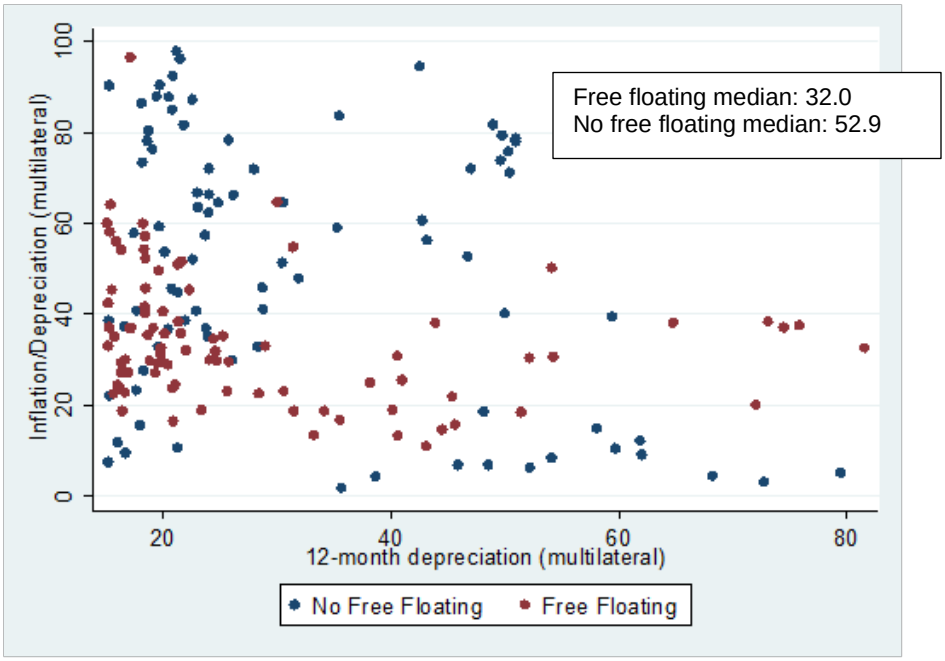
	Traded Goods	Non-traded Goods
Mean	25.8	26.5
Median	24.7	23.6

Note: Monthly data since January 2001 for Brazil, Chile, Colombia, Paraguay, Peru and Uruguay.

[4] For Uruguay we construct our own index as shown in Section 4. Argentina is not included in this exercise.

Finally, to check the robustness of the results, we focus on a multilateral measure of the exchange rate. We use the IMF calculation of the effective exchange rate. Figure 5, which can be compared to Figure 3, shows broadly similar results to the case of bilateral exchange rate, except a somewhat higher degree of pass-through in the case of non-floating exchange rate regimes.

Figure 5. Pass-through at Different Levels of Exchange Rate Depreciation (effective exchange rate)



Note: Monthly data since January 1992 for Argentina, Brazil, Chile, Colombia, Paraguay, Peru and Uruguay. Restricted to inflation<50%, pass-through between 0% and 100%, and depreciation between 15% and 100%.

4. VAR Estimation

4.1 Model

To study the response of prices to exchange rate shocks, we estimate a vector autoregressive model (VAR) for six South American countries: Brazil, Chile, Colombia, Paraguay, Peru and Uruguay. We use monthly data starting in 1999 in Chile, and at the beginning of the 2000s in the other countries,[5] in order to ensure homogeneity in the exchange rate system throughout the sample: during the sample periods all of these countries maintained floating exchange rate regimes.

[5] Brazil 2002:06-2015:12, Chile 1999:11-2015:12, Colombia 2003:01-2015:12, Paraguay 2004:01-2015:12, Peru 2003:11-2015:12 and Uruguay 2003:01-2015:12.

We assume that the domestic economy can be described by the following structural form equation:

$$A(L)Y_t = c + B(L)X_t + \varepsilon_t, \qquad (1)$$

where *A(L)* is a $n \times n$ matrix polynomial in the lag operator; *B(L)* is a $n \times k$ matrix polynomial in the lag operator; Y_t is a $n \times 1$ vector of endogenous variables; X_t is a $k \times 1$ vector of exogenous foreign variables; and ε_t is a $n \times 1$ vector of structural disturbances, with $Var(\varepsilon_t) = \Lambda$, where Λ is a diagonal matrix.[6]

The endogenous variables included in *Y* are a monthly measure of the output gap available for each country (for instance, one based on the industrial production index, IPI_{gap}), the nominal sort-term domestic interest rate (i^{dom}), the yearly change of the nominal exchange rate against the US dollar (ΔE), the yearly change in traded goods prices (π^{TG}), and the yearly change in the consumer price index (π^{CPI}):

$$Y' = [IPI_{gap}, i^{dom}, \Delta E, \pi^{TG}, \pi^{CPI}]. \qquad (2)$$

A more detailed description of the data for each country is provided in Appendix A. The output gap is calculated as deviations from the HP filter trend. Depending upon data availability, traded goods prices are either obtained from official sources or constructed from components of the price index as described below.

The exogenous variables included in *X* are the yearly change in commodity prices (π^{Com}), which is calculated based on each country main exports, and yearly changes in oil prices (West Texas Intermediate oil price, π^{WTI}):

$$X' = [\pi^{Com}, \pi^{WTI}]. \qquad (3)$$

These variables are included to control for fluctuations in energy prices and commodity prices. The model also includes a constant and country-specific dummy variables.

In order to get a sense of the different factors that affect the degree of pass-through, we include both the aggregate traded-goods price index and the aggregate consumer price index. Traded good prices measure a more direct, or first-round, impact of the exchange rate changes not only on exports and imports but also, for example, on the prices charged by domestic firms whose products are subject to external competition. The overall price index includes also the

[6] For each country we select the lag order according to the Akaike Information Criterion and the variables and lags included in *X*.

reaction of nontraded goods prices, which to some extent are affected by the cost of imported inputs but also reflect inflation expectations and the credibility of monetary policy. Other studies have also looked at disaggregated measures but have generally focused on import prices rather than an aggregate of traded goods prices. For example, McCarthy, (1999), Hahn (2003), Ca'Zorzi et al. (2007), Choudhri and Hakura (2012) and Choudhri, Faruqee and Hakura (2005) estimate VARs with import and/or export prices—in addition to domestic producer and consumer prices—but they do not consider traded goods as a whole.[7]

Table 3 presents the measure of traded goods prices used in the econometric analysis. In the case of Uruguay, where there is no official index, we constructed one by excluding from the CPI services (health, education, etc.) and housing. The table also shows the weight in the overall CPI of the traded goods index used in the estimation. These weights are larger in countries where the ratio of exports and imports to GDP is larger (see Appendix B).

Table 3. Traded and Non-traded Goods Price Indexes

Country	Traded	Non-traded	Share of traded goods in overall CPI*
Brazil	IpeaData: Processed and semi-processed food, cleaning and beauty products, furniture, household items, equipment	IpeaData: Fresh products, food away from home, rent, housing operational expenses, vehicle expenses	35%
Chile	INE: For example, all goods not perishable are included into this category	INE: 85 non-traded products such as education, services and health	56%
Colombia	Central Bank of Colombia: Traded goods prices without food or regulated prices	Central Bank of Colombia: Non-traded goods prices without food or regulated prices	26%
Paraguay	Central Bank of Paraguay: Traded goods prices without fruits and vegetables	Central Bank of Paraguay: Non-traded goods prices	62%
Peru	Central Bank of Peru: Food, textile and footwear, fuel, electrical appliances and other tradables	Central Bank of Peru: Food, education, health, public services, transport, rents and other non-tradables	37%
Uruguay	Authors' calculations: Food and beverages, textile and footwear, furniture and domestic appliances	Authors' calculations: Housing, health, transport and communications, leisure and recreation, education, restaurants and hotels	41%

*Corresponds to the weight of the traded goods price index defined in the table in overall CPI.

[7] In addition, Justel and Sansone (2015) measure pass-through to core inflation and IMF (2015) compares the degree of pass-through with the share of imports in the price index.

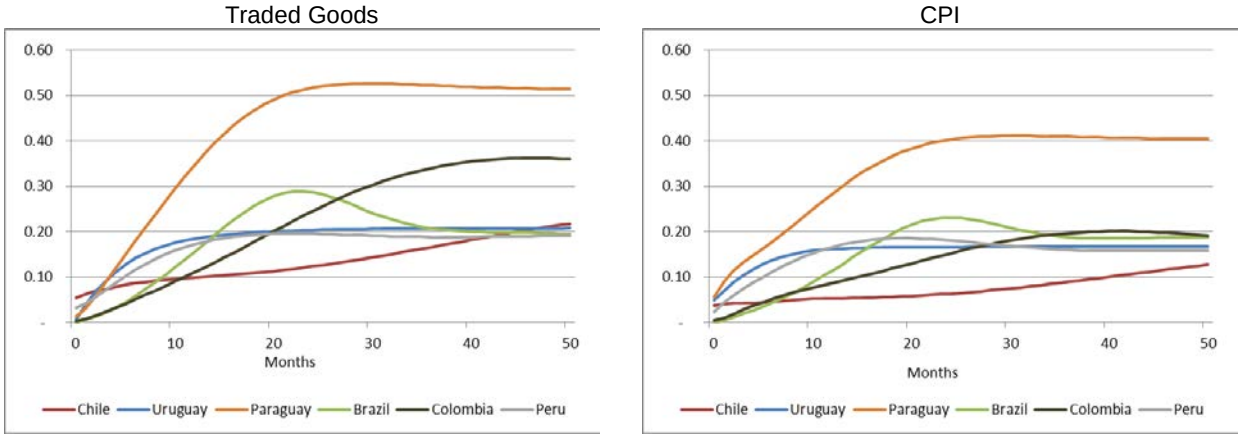
4.2 Results

Impulse response functions (IRF) for the structural shocks are estimated using the Cholesky decomposition and applying the ordering of the variables given by (2).[8] The impulse response functions of traded goods inflation and CPI inflation to the orthogonalized shock of the exchange rate provide estimates of the effect of this variable on traded goods and domestic inflation. The ERPT is calculated normalizing the cumulative changes in prices relative to the cumulative changes in the nominal exchange rate due to a shock to the nominal exchange rate.

The average cumulative response of traded goods inflation to an exchange rate shock in the six countries is 18 percent in the first year and 26 percent after two years. This implies that, on average, after a depreciation shock of 10 percent, traded goods prices rise 2.6 percent after two years.

Figure 6 shows the estimated ERPT for each country. In Appendix B, we show that these responses are significant at a 90 percent confidence level in all cases except for Chile (after 14 months) and Peru (after two years).[9] The figure shows that Paraguay seems to have a higher degree of ERPT to traded goods prices than the other countries. One explanation for this could be the fact that Paraguay is relatively more open than the other economies (see Appendix B). This is consistent with the results in McCarthy (1999), who finds that the pass-through is somewhat stronger in countries with a larger import share.

Figure 6. Exchange Rate pass-through to Traded Goods and CPI Inflation



[8] This ordering follows the same logic to the one used in Justel and Sansone (2015) for the case of Chile. The authors find that the ordering of the variables does not affect their results in the case of Chile, except in one case.
[9] We thank Santiago Justel and Andrés Sansone for providing their code to calculate the bands.

Considering the ERPT to CPI inflation, the average cumulative response is 14 percent after one year and 20 percent after two years, slightly below the ERPT to traded goods but not significantly different. Again the results are significant at a 90 percent confidence level in all countries except for Chile (after 9 months) and Peru (after 19 months), and there is a higher effect on prices in the case of Paraguay.

Despite the relatively lower ERPT in the past two decades, the exchange rate continues to be a large determinant of inflation in several countries. Table 4 shows the variance decomposition of inflation at various horizons. While our estimation of the ERPT provides information about how prices respond to exchange rate shocks, variance decompositions enable us to determine the importance of the different shocks for inflation volatility in each country. In the cases of Brazil and Colombia more than 50 percent of the medium and long-term fluctuations in both price indices are driven by shocks to the exchange rate. In Uruguay, exchange rate shocks explain about one quarter of the fluctuations in traded goods prices and half of the volatility of consumer prices. Interestingly, in Uruguay even short-term fluctuations in the CPI are largely driven by exchange rate shocks which might be explained by the way agents form their expectations in a highly dollarized country. In Chile and Paraguay, most movements in prices are due to shocks to the prices of traded goods (one example of this type of shocks are mark-up shocks). As shown in Appendix B, these are the two most open economies in the sample. In Peru, shocks to the nominal exchange rate explain around 20 percent of the fluctuations in prices. It is worth noting that in many cases exchange rate shocks have been more important than output or interest rates shocks (grouped in “others”) in explaining inflation fluctuations.

Table 4. Variance Decomposition of Inflation

Country	Shock	Traded goods inflation				CPI inflation			
		3	**6**	**12**	**24**	**3**	**6**	**12**	**24**
Brazil	Exchange rate	3	23	50	44	5	24	53	52
	Traded goods prices	91	60	18	10	22	18	6	4
	CPI	1	0	2	9	68	46	15	10
	Others	5	16	30	37	4	13	26	35
Chile	Exchange rate	8	8	8	9	8	6	5	4
	Traded goods prices	92	86	81	78	57	61	56	54
	CPI	0	4	6	6	34	31	34	34
	Others	0	2	5	8	1	2	6	8
Colombia	Exchange rate	24	63	78	81	13	47	67	68
	Traded goods prices	75	32	14	11	4	3	2	2
	CPI	0	0	0	2	79	44	21	16
	Others	1	4	7	7	5	6	10	14
Paraguay	Exchange rate	4	9	12	12	12	14	15	15
	Traded goods prices	88	76	70	66	31	43	47	46
	CPI	0	1	4	4	56	36	29	27
	Others	8	13	14	19	2	7	9	12
Peru	Exchange rate	7	16	22	22	8	15	19	18
	Traded goods prices	89	63	39	36	42	37	26	24
	CPI	2	9	15	17	45	32	25	23
	Others	3	12	24	26	4	16	31	35
Uruguay	Exchange rate	9	24	28	28	29	46	49	49
	Traded goods prices	87	73	68	68	29	23	23	23
	CPI	0	0	0	0	41	31	27	27
	Others	3	3	4	4	1	1	1	1

Note: The columns indicate forecast horizon in months.

5. Conclusions

The extent of exchange rate pass-through has again become an important policy question in Latin America with the large depreciations and increased volatility that resulted from deteriorating external conditions over the past two years. Estimating the size of the pass-through and better understanding the channel of transmission of the exchange rate are essential elements to assess the effectiveness of exchange rate adjustments to adjust to external imbalances and isolate the domestic economy from international shocks. The results in this paper can be considered optimistic. The findings point to moderate pass-through rates in the short and medium run for both traded and nontraded goods. This represents a moderation relative to what the evidence

suggested a decade or two ago, and it is a sign that the stronger degree of credibility of the monetary framework has improved the tradeoff over the past two decades.

The econometric estimates indicate a pass-through to the general price level of 14 percent up to one year and 20 percent over a two-year time horizon. For traded goods, the average estimates are 4 to 6 percentage points higher, although there is more discrepancy between countries. Over time, an inspection of the data indicates that the pass-through has been declining and has benefitted from the adoption of floating exchange rates and especially an increase in monetary policy credibility. The gains in credibility in recent years have accompanied the success of floating exchange rate/inflation targeting systems. The economies in the region seemed to have broken free from the policy dilemmas underlying the "fear of floating" problem in emerging markets of some 20 years ago (Calvo and Reinhart, 2002).

One should exercise some degree of caution in assessing these results. Average levels of the pass-through rate—measured as the ratio of inflation to exchange rate depreciation over one year—provide a useful characterization of the effect for different countries and over time. However, these pass-through rates are not strictly comparable with each other. They result from different disturbances affecting the economy and inflation reflects not only the exchange rate shock but also the aggregate effect of every shock impacting the economy at one time.[10] The VAR estimates in Section 4, however, are immune to this problem as they isolate an orthogonal shock to the exchange rate and measure its pass-through to prices in a consistent way.

It may be premature, however, to announce that monetary credibility is robust and high rates of pass-through are no longer an issue. For the FSD group countries, there have not been many episodes of large depreciation since they adopted monetary frameworks with floating exchange rates and inflation targeting. The current episode is hardly two years old and may not have run its course. It nonetheless does make sense to focus on large depreciation events, as the current one, for various reasons (Burstein, Eichenbaum and Rebelo, 2007, and De Gregorio, 2016). First, the effect may be easier to observe and measure as the exchange rate is likely to be the dominant shock. Also, it is more likely that large depreciations cross a certain threshold to

[10] Frederic Mishkin, Governor of the FRB, warned about this issue: *"An important caveat to the conclusion that exchange rate pass-through to consumer price inflation is now very low is that the empirical evidence on which it rests is mainly unconditional in nature. In other words, it reflects the average outcome across a range of different episodes but does not tell us how the relationship may vary depending on which shocks hit the economy. However, certain specific shocks and the responses to them may be associated with considerably higher pass-through than indicated by these average relationships."* (Speech of Governor Frederic S. Mishkin at the Norges Bank Conference on Monetary Policy, Oslo, Norway, 2008).

trigger a more rapid response in prices and wages, as would be the case if there are fixed "menu" costs to these adjustments. Moreover, central banks should be more concerned about the potential pass-through effect in the case of large depreciations, as they may potentially involve a larger departure from the inflation target. An accurate estimate of the "equilibrium" pass-through would help to separate temporary effects owing to the depreciation from the underlying inflation rate in the economy and calibrate the monetary policy response appropriately.

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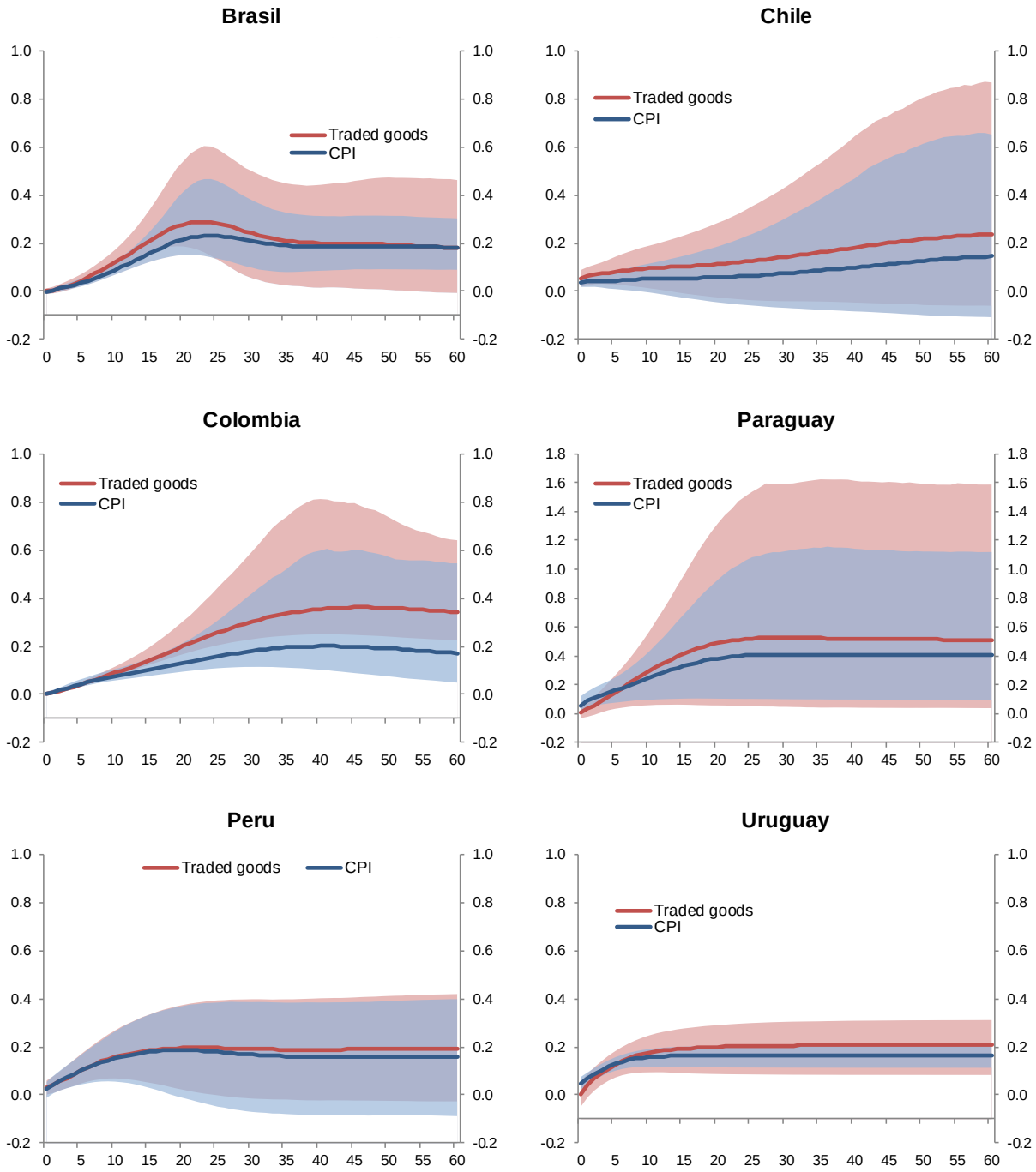
Appendix A. Data Appendix

Variable	Description	Data source
Brasil		
Output measure	Industrial production index (2012=100)	IpeaData
Domestic interest rate	Selic rate	Central Bank of Brazil
Exchange rate	LC/USD commercial exchange rate	IpeaData
Traded goods price index	IPCA-free prices-tradables (% change)	IpeaData
Consumer price index	IPCA-extended consumer price index (Dec 1993=100)	IpeaData
Commodity price index	Exports-weighted commodity price index	Bloomberg-BID
WTI	West Texas Intermediate oil price	Bloomberg
Chile		
Output measure	IMACEC-Monthly economic activity index (2008=100)	Central Bank of Chile
Domestic interest rate	Monetary policy rate	Central Bank of Chile
Exchange rate	LC/USD exchange rate	Central Bank of Chile
Traded goods price index	IPCT-traded goods prices (2013=100)	INE
Consumer price index	CPI (2013=100)	INE
Commodity price index	Exports-weighted commodity price index	Bloomberg-BID
WTI	West Texas Intermediate oil price	Bloomberg
Colombia		
Output measure	IMACO-Colombian economic activity index (1990=100)	Central Bank of Colombia
Domestic interest rate	Monetary policy intervention rate	Central Bank of Colombia
Exchange rate	LC/USD exchange rate	Central Bank of Colombia
Traded goods price index	Tradable goods without food (2008=100)	Central Bank of Colombia
Consumer price index	CPI (2008=100)	Central Bank of Colombia
WTI	West Texas Intermediate oil price	Bloomberg
Paraguay		
Output measure	IMAEP-Monthly Economic Activity Indicator	Central Bank of Paraguay
Domestic interest rate	Call interbank	Central Bank of Paraguay
Exchange rate	LC/USD exchange rate	Central Bank of Paraguay
Traded goods price index	Traded goods prices without fruits and vegetables	Central Bank of Paraguay
Consumer price index	Asuncion Metropolitan area CPI (2007=100)	Central Bank of Paraguay
Commodity price index	Exports-weighted commodity price index	Bloomberg-BID
WTI	West Texas Intermediate oil price	Bloomberg
Peru		
Output measure	PBI-Gross domestic product (2007=100)	Central Bank of Peru
Domestic interest rate	Monetary policy rate	Central Bank of Peru
Exchange rate	LC/USD exchange rate	Central Bank of Peru
Traded goods price index	Lima traded goods prices (2009=100)	Central Bank of Peru
Consumer price index	Lima CPI (2009=100)	Central Bank of Peru
WTI	West Texas Intermediate oil price	Bloomberg
Uruguay		
Output measure	IVF-Industrial production index (2006=100)	INE
Domestic interest rate	Average lending rate for households and firms	Central Bank of Uruguay
Exchange rate	LC/USD exchange rate	Central Bank of Uruguay
Traded goods price index	Traded goods price index	INE-BID
Consumer price index	CPI (Dec 2010=100)	INE
Commodity price index	Exports-weighted commodity price index	Bloomberg-BID
WTI	West Texas Intermediate oil price	Bloomberg

Appendix B. Additional Tables and Figures

Figure B1. Exchange Rate Pass-through and 90 Percent Confidence Bands



Note: Estimated ERPT and 90 percent confidence bands computed with bootstrap.

Table B1. Average Exports and Imports over GDP, 2000-2015

	Exports/GDP	Imports/GDP
Brazil	13%	12%
Chile	36%	32%
Colombia	17%	18%
Paraguay	52%	45%
Peru	24%	22%
Uruguay	25%	25%