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Real Exchange Rates in Latin America: what does the 20th Century reveal?

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Abstract
Using a new data set for the whole period 1900-2005, this paper analyses the behaviour of real multilateral exchange rates in the six largest economies of Latin America. The main aims are to identify any trends or shifts in the equilibrium position and to test for mean reversion. The key findings are the following: i) evidence of real depreciation at the end of the period, compared to the starting position; ii) significant differences in real exchange rates derived using symmetric and asymmetric definitions; iii) a moderate level of intra-country synchronicity, though results vary across periods and pairs of countries; iv) not rejection of the unit-root hypothesis for the series in levels; however, v) the series can be made stationary after allowing for trends structural breaks. For the adjusted series, the half-life of the process ranges from 0.8 to 2.5 years.

Keywords: Economic Development, Real Exchange Rates, Purchasing Power Parity, Latin America
JEL Classification: O11, F41, N16

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Introduction[•]

The purpose of this paper is to study the behaviour of the real exchange rate (RER) in Latin America during the XXth century. In particular, we are interested in identifying any trends or shifts in the equilibrium position and in testing for the presence of mean reversion. In turn, these two aspects are informative of key issues such as the validity of the purchasing power parity concept (PPP) in developing countries, the persistence of shocks to the RER, and the potential influence of fundamentals such as relative productivities, trade openness and terms of trade.

A long-term approach is essential as we are dealing with regularities that by their nature take time to emerge and consolidate. This is also a necessity in terms of improving the power of econometric tests for non-stationarity and the accuracy of estimates of mean reversion. We cover RER developments in the six largest economies in Lain America (LA6), namely Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela.[1] The inclusion of a representative group of countries in the region is desirable in order to identify patterns that are not country-specific, and to allow for a comparative analysis among countries in the process of development as well as between them and developed economies.

We centre our analysis on two of the most commonly-used definitions for the real exchange rate in empirical work: the purchasing power parity (or symmetric definition); and a proxy for the ratio of tradable to non-tradable prices. The first measure focuses on intra-country utility comparisons and living standards; the second on macroeconomic equilibrium. There is no theoretical reason for the RER under both definitions to coincide or converge (Edwards, 1989), so whether they in fact tell a similar story or not, needs to be confirmed empirically.

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[1] The LA6 group accounts for about three quarters of the regional GDP and population throughout the century, which makes it highly representative of the continent as a whole.

An important part of our work is building a consistent set of series for our group of economies over the whole century. Although, there are available long-term real exchange rate series for a number of Latin American countries, they are largely bilateral rates with the US and computed with US price indices to reflect world prices. The use of bilateral rates introduces a bias, particularly in the early and late decades of the century characterised by a more geographically diversified trade structure; whereas relying on world prices that are not directly related to the country's trade flows misses out important aspects related to terms of trade effects. In order to address these shortcomings, we constructed multilateral or effective real exchange rates under the two empirical definitions - this dataset is in itself an important contribution.

In terms of the literature, the present work fills a gap in multi-country studies of real exchange rates in developing countries adopting a long-run approach, as most of the empirical work tends to concentrate on the second half of the century (e.g., Edwards; Wood, 1991). Taylor (2000) examines the RER in twenty economies - including Argentina, Brazil, and Mexico - over more than a 100 years, but he uses bilateral rates and the sample is dominated by developed countries. Otherwise, there are a limited number of country-specific works covering most of the century (e.g., Richaud et al, 2003, on Argentina; Noriega & Medina, 2003, on Mexico), and because of differences in aims and methodology, taken together, they can not provide a wider view of developments at a regional level.

The paper is structured as follows. The first section introduces key issues in the literature dealing with RER and look at some specificities of the LA6. The following section discusses the most commonly-used definitions of RER and proposes a set of multilateral and bilateral indices. Next comes an analysis of the main statistical properties of the series and a discussion on intra-country comparisons. Section four tests for non-stationarity [2] and structural breaks, and calculates the half-time process of mean reversion in the multilateral RER series. Finally, there is a section of conclusions. In addition, there are five annexes with methodological notes, detailed

[2] A stationary series exhibits a time-independent mean and variance. In addition, co-variances between two given dates are independent of time.

results, and sources.

I. Key Issues related to Real Exchange Rates over the Long-run

This section summarises key issues related to the long-term RER. First, we briefly review prominent theoretical predictions and empirical findings on stability properties, persistence of shocks, and the possibility of trending behaviour. Then we focus on relevant features of the LA6 economies.

Long-run stability of the real exchange rate

The absolute version of the Purchasing Power Parity (PPP) doctrine states that the equilibrium nominal exchange rate between two countries will equal the ratio of the countries' price levels. In its relative version the PPP states that the nominal exchange rate equilibrium will change according to the relative change in the countries' price levels.[3] The validity of PPP as a long-run equilibrium condition is usually assessed by whether real exchange rates tend to settle down at an equilibrium level. Under the PPP view, shocks to the RER should have a temporary effect, and, in the absence of further disturbances, the series should move towards its mean value. The mean reversing property of the series is a necessary condition for long run PPP to hold (Froot & Rogoff, 1995). However, there are cases where the RER series lacks a constant mean over the whole period due to the presence of one or more structural breaks. Hegwood & Papell (1998) refer to this condition as a quasi PPP.

Most of the evidence coming out of the analysis of data from the main developed economies after the collapse of Bretton Woods has rejected the validity of the PPP hypothesis to account for the RER behaviour in the short term (Adler & Lehmann, 1983; and Enders, 1988). But more recent studies covering a much longer time span (over a century or more) have supported the case for mean reversion as a long-run phenomenon. For instance, Lothian and Taylor (1996) in a study with annual data over 200 years in the US, the UK and France, found that real exchange rates tended to return to their long-term equilibrium values, although the degree of short-term persistence was high.[4] However, as Froot and Rogoff (1995) have pointed out, there is

[3] Since price indices in various countries are rarely based on the same basket of goods, the empirical work usually tests relative PPP.

[4] See Taylor (2003) for a recent survey on the empirical work. See also the surveys by Sarno and Taylor (2002), Froot and Rogoff (1995); and Frankel and Rose (1996).

the possibility that the extent to which PPP holds in the long run might be exaggerated by favouring the inclusion of wealthy countries, or economies that already displayed high living standards at the turn of the last century. The authors refer to this as the “survivors” bias.

A commonly-used measure of the speed of mean reversion is the half-life process *n* (Froot & Rogoff, 1995). It is defined as the number of years that it takes for deviations from PPP to subside permanently below 0.5 in response to a unit shock in the level of the series.[5] The degree of persistence can be informative about what are the principal forces driving RER movements. In particular, if deviations are slow to subside (for example, in the case of series close to a random walk), then it is most likely that the shocks originate in the real side - principally technology related, whereas cases of little persistence point to shocks primarily attributable to aggregate demand, such as, for example, innovations to monetary policy (Rogoff, 1996).

The prevailing consensus in the long-span and panel unit-root studies focusing on industrialised economies is that the half-life process of mean reversion of real exchange rates – in levels - ranges between 3 and 5 years (Rogoff, 1996; and Frankel & Rose, 1996). This apparently low speed of adjustment is the origin of the Rogoff’s puzzle.[6] One way of making sense of this puzzle is by allowing for structural breaks or underlying shifts in the long-run equilibrium mean (although this can in itself be taken as evidence against long-run PPP).

For instance, Lothian and Taylor (2004), after allowing for shifts in the equilibrium dollar-sterling real rate over two centuries suggest that the half-life deviations from PPP of the dollar-sterling real rate may be as low as 2.5 years (compared to 6 years in the original series). Also, Hegwood & Papell (1998) found in their long-span study of

[5] This is calculated as: $n = \ln(0.5)/\mathrm{Ln}(\sum_{i=1}^{k}\rho_i)$, where the denominator is the log value of the sum of the estimated coefficients in the autoregressive process of the type: $\tilde{y}_t = c + \sum_{i=1}^{k}\rho_i\tilde{y}_{t-i} + e_t$. The smaller the level of autocorrelation in the real exchange rate series, the faster the return to the mean.

[6] Rogoff (1996) argues that the estimated speed of adjustment of real exchange rates is difficult to justify in terms of wage or price stickiness, or shocks related to real factors such as technology or tastes.

six RER series (all from OECD economies) that reversion to the changing mean is much faster than reversion to a fixed mean. After accounting for structural breaks (but without de-trending), their half-time estimates are between 0.5 and 2.5 years. This range of speed of adjustment can be more easily justified in terms of nominal rigidities

Shift in equilibrium position

In contrast with most PPP empirical work, this study centres on economies on the periphery (to use Prebisch's term) which went through a drastic process of structural transformation and industrialisation, and secular changes in their terms of trade during the period covered. This is likely to imply trend behaviour and shifts in the equilibrium position of the RER, two features which undermine the case for stability around a constant mean and a low level of persistence (under the strict PPP concept).

Indeed, economic theory suggests various ways in which the dynamics associated with economic development can affect the long-term RER. The most prominent is via productivity differentials. According to the Harrod-Balassa-Samuelson model (HBS),[7] if the labour productivity of a given country in producing tradable goods (e.g., manufactures) relative to their productivity in producing non-tradable goods (e.g., services) grows faster than abroad, then the country's currency will appreciate in real terms. Conversely, if the relative productivity growth of tradable goods workers is lower than abroad, the currency depreciates (see Annex B for a formal presentation of the hypothesis). The HBS model implies that poor countries (i.e. with a relatively lower labour productivity in producing tradable goods) tend to have lower non-tradable prices relative to rich countries and that the real exchange rate should appreciate as a country's real per-capita income rises relative to those in more advanced countries.

A crucial assumption in the HBS argument is that the "law of one price" rules the formation of tradable goods prices across countries, whereas those in the non-tradable or sheltered sector are determined by domestic supply and demand conditions. In addition, it is assumed that wages within a country are equalised by competition

[7] The seminal contributions are: Balassa (1964); Samuelson (1964), and Harrod (1957).

between the two sectors. Under these conditions, productivity rises in the tradable sector will lead to wage rises in that sector, whilst keeping prices unchanged. But workers in the non-tradable sector will also demand comparable pay rises, and this will lead to higher non-tradable prices and, in consequence, to a rise in the overall price index. If the nominal exchange rate has remained constant, it must now appear overvalued on the basis of price comparison with the country's trade partners. [8] Overall, the evidence on the role of the HBS effect is mixed, though there are good theoretical reasons to expect that technical progress and sustained productivity changes play a significant role in determining the RER (Sarno & Taylor 2002).

Besides productivity differentials there are other fundamental variables shaping the long run equilibrium of relative prices.[9] First, a higher level of openness to international trade (e.g., after the dismantling of trade barriers) is likely to depreciate the real exchange rate owing to lower domestic prices; whilst protectionist measures are set to create pressures on the opposite direction. Secondly, a lasting improvement in the terms of trade is associated with a stronger RER because of its contribution to the external accounts and to the supply of foreign currency; whilst a secular deterioration generates a drive towards real depreciation. Finally, net capital flows have the potential to affect the real exchange rate, with sustained inflows creating pressures for real appreciation.

Some features of the LA6 [10]

The "commodity lottery" [11] provides a source of differences and similarities in our group of economies: coffee in Brazil and Colombia, oil in Venezuela and Mexico, copper in Chile, and grains and meat in Argentina. Although the lottery brought luck

[8] At least two caveats are in order with the potential to undermine the workings of the HBS effect: i) to the extent that the tradable sector is protected from foreign competition (either by high trade taxes or transport costs), the tradability of the sector is reduced. In consequence, as with non-tradable goods, prices are partly determined by internal demand and supply forces. ii) Unemployment or under-employment in the labour market (with the Lewis unlimited supply of labour as an extreme case), weakens the link between an increase in productivity in the tradable sector and upward pressures on non-tradable prices.

[9] See Edwards (1989) for a detailed treatment of the role of the fundamentals shaping real exchange rate behaviour. Also, Montiel (1999) and Neary (1988).

[10] For a comprehensive account of the economic history of the region during the XXth century see Cárdenas et al (2000), three volumes; and Thorp (1998).

[11] The term refers to the joint effect of the magnitude, timing, stability, and product composition of exports (Díaz-Alejandro, 1984).

unevenly to the Latin American countries, all, with differences in degree, shared the same fate in terms of export concentration. With one or two commodities accounting for more than 60% of total exports in several countries for most of the time – particularly before 1970. High export concentration and the failure to develop a stable export base resulted in increased terms of trade volatility – both net barter and income – with direct implications for relative prices, and a source of stop-go patterns in economic activity.

Commodity cycles have been an influential factor in the RER behaviour of the LA6. First, via their impact on the terms of trade and the external accounts, and indirectly, through their implications for fiscal policy, particularly in mining and oil economies where the commodity revenues are a major contributor to the budget. The latter group, other things being equal, are more prone to real appreciation pressures, and to manifestations of Dutch disease.[12] Meanwhile, agricultural economies, in general, tend to have a more cyclical pattern in their terms of trade, which should also be reflected in the behaviour of their real exchange rates.

In our sample of countries the openness cycle was closely related to the process of economic development and industrialisation. Broadly speaking, there were three main stages in terms of development strategies. First, an export-led growth episode during the first three decades of the century that came to an end with the collapse of commodity prices and capital flows in the 1930s. This led to a wave of devaluations and protectionism which shifted relative prices in favour of domestic industries and agricultural production.

This was a time of experimentation that can be thought as an empirical stage of state-led industrialisation. This transition gave way to a more conscious industrialisation strategy, the so-called ISI model. The main ingredients of this model were trade barriers, induced changes in the internal terms of trade against traditional primary exports, strong public sector investment in infrastructure and the rationing of foreign exchange. The classic stage of inward-looking development dated from the late 1940s to the early 1960s in most medium and larger economies. Then, gradually,

[12] A sustained appreciation of the real exchange rate caused by the discovery of a natural resource or a lasting increase in the price of the main export product (Corden & Neary, 1982).

policymakers started to give more emphasis to export promotion. Balance of payments and fiscal difficulties in the 1970s made the opening of trade more pressing in many countries. The debt crisis and subsequent economic reforms pushed the economies further into a new period of export-led growth with a more prominent role for the market and a retreat of the state.

The review of issues raises *a priory* doubts regarding the likelihood of having constancy in the RER equilibrium of the LA6 group during the period under analysis. However, the end result is difficult to predict owing to the combined effect of several forces, the direction and strength on which are likely to have varied over time and between countries. Therefore, there is a compelling case for an empirical study on the behaviour of RER in the region. But first we need to discuss definitions and to construct the series.

II. Real Exchange Rate Definitions and Indices

In most modern theoretical work the RER is defined as the internal relative price of tradable goods (P_T) and non-tradable goods (P_N):

$$(1)\quad RER_{DE} = \frac{P_T}{P_N}$$

This is the definition most preferred by economists working with small, open economies because it captures essential aspects of the price adjustment mechanism in relation to external balance problems and internal disequilibrium. Hereafter we will refer to this as the "dependent economy" definition (DE).[13]

However, one major disadvantage of this concept is its limited empirical applicability due to measurement problems and lack of appropriate data – even for a recent period.

[13] The term is from Dornbusch (1980), who uses it to refer to the modelling tradition of the Australian model (Salter, 1959; and Swan, 1960), Scandinavian model (Aukrust, 1977), and the analysis of Latin American economies (Díaz-Alejandro, 1965). Wood (1991) refers to this as the "theoretical" definition, in contrast to the "statistical" definition based on consumer price differentials. But these labels may be misleading as the latter is also used at the theoretical level in the PPP doctrine.

In this study we will primarily focus on two of the most-commonly used RER in the empirical literature.[14]

Empirical definitions of the RER

Harberger (2004) favours the expression given in (2) not only as the most convenient from the point of view of the applied work, but also for its own theoretical merits. The RER under this definition is the key equilibrating variable of a country's external accounts.

(2) $RER_H = E\frac{P_T^*}{P_C}$

where E stands for the nominal exchange rate (domestic currency per unit of foreign currency), P_T^* is the world price index of tradable goods, and P_C is the consumer price index (CPI).

There are several options for P_T^* in (2). We prefer to use the border import price index facing a particular country, $P_M^\wedge$.[15] The use of this index results in a real import exchange rate, which can be interpreted as the number of basket imports that can be bought with one consumption basket in a given country. In this way we avoid some of the ambiguities that the use of a composite index of tradable goods (including both imports and exports) can create. For instance, a country benefiting from a commodity windfall should experience a real appreciation caused by the increased domestic spending funded by the prise rise (this assumes a fixed exchange rate regime). However, an RER measure that uses an index comprising all tradable goods can end up indicating a real depreciation if the commodity has sufficient weight to make the tradable index rise (Harberger, 2004).

Other authors (eg. Edwards, 1989; Baffes et al, 1997) proxy P_T^* with the producer price index (PPI) or the wholesale index (WPI) of the main foreign trading partner, as

[14] Another popular measure has nominal wages in the numerator instead of P_N or P_C. In which case, the real exchange rate reflects the purchasing power of local wages in terms of foreign goods. This is a particularly convenient variant to study adjustment costs (see Dornbusch, 1988).

[15] We use a circumflex ^ to denote that the index is built based on the basket of goods actually traded by a particular country, whereas an asterisk * can also refer to a price based on a basket of goods of a foreign country – eg. the main trading partner.

both indices tend to exclude retail sale services in their derivation. One main drawback in using these proxies is that the same foreign price index is applied to all countries, without taking into account possible variations in the composition of their consumption baskets (Chinn, 2006). This problem is magnified in the case of oil economies where the main export product has little weight in the consumption basket – owing to a dissociation between international and local costs of energy – but tends to have a significant weight in the main trading partners'. In addition, different degrees of import substitution meant that the import mix could differ significantly.[16]

Next we focus attention on the PPP definition:

(3) $RER_{ppp} = E\frac{P_C^*}{P_C}$

Under this concept the exchange rate is the variable that equalises the cost of two identical baskets of goods between two countries. A key departure from the two previous definitions is that this uses the same type of price index in the numerator and the denominator. Therefore, it is also referred to as the symmetric definition. As before, E stands for the nominal exchange rate. P_C denotes the consumer price level at home, and P_C^* the consumer price index in the comparator country.

Note that, in contrast to the Dependent-Economy definition, expressions (2) and (3) do not directly include the effect of protection in the home country in the numerator, which impact is only felt when it feeds through to the general price index.

In Annex B we derive expressions linking the three definitions. Here we present some of the results and comment on the potential for convergent or divergent behaviour in RER series derived from them. It is assumed that a fixed exchange rate regime is in place, and that there are no taxes on trade. First, the log values of the DE measure (r_{DE}) and those of the Haberger concept (r_H) are related by the following expression:

(4) $r_{DE} = \frac{r_H + (1-\beta)\tau}{(1-\alpha)}$

[16] In Annex C we compare series with both the foreign PPI and the import unit values for each of the LA6 countries.

where β is the share of import goods in the countries traded goods, τ is the logged terms of trade, and α is the expenditure share on tradable goods in the home country.

The main difference between both RER concepts in (4) is owing to the added impact of a change in the terms of trade on the price of tradables (priced in domestic currency). If the main export good is experiencing an increase in price, it will have an impact on P_T, which effect will depend on the weight of the export goods in the consumer basket. This effect is not included in our H definition, as it only considers the price of import goods. In both cases the internal spending of an export windfall will put upward pressures on the price of non-tradables, thus bringing about a real appreciation – other things being equal.

Meanwhile, the link between the log values of the Harberger and the PPP (r_{PPP}) measures is given by the following expression:

(5) $r_H = r_{PPP} - (1-\beta)\tau + (1-\delta)(p_T^* - p_N^*)$

where p_T^* and p_N^* are the logarithms of the price of tradable and non-tradable goods in the foreign country.

In this case movements in both measures tend to differ, and can even move in opposite directions depending on the behaviour of the relative prices in the foreign country. In the following section we describe the derivation of a set of multilateral and bilateral exchange rate indices according to the two empirical definitions.

Multilateral and bilateral real exchange rates series

Constructing series over the last century for our sample of countries involves making a number of choices, first about the definition, the coverage of trade partners (bilateral or multilateral), and then about the nominal variables used to calculate the real exchange rate.[17] At different times, the LA6 countries adopted various exchange rate regimes, ranging from the gold and gold-exchange standard, fixed, multiple rates (with many variations), crawling pegs, and, more recently, floating rates. But overall,

[17] See Chinn (2006) for a discussion of the choices in the construction of real effective exchange rates.

exchange regimes with a fixed or a controlled rate for most transactions in the trade account were the norm.[18]

To deal with such complexity, we constructed five different real exchange rate series for each of the LA6 countries, three multilateral and two bilateral.[19] They are:

- *REERpm* : a multilateral index calculated using import unit value indices as proxies for the foreign import prices, and CPIs to reflect general prices at home.
- *REEppi*: a multilateral rate that uses, when possible, wholesale or producer price indices for the main trading partners.
- *REERcpi* : a multilateral rate index calculated using CPIs for the main trading partners, as well as for the home country (or the GDP deflators).

And two indices of bilateral exchange rates:

- *RER$cpi*: a bilateral real exchange rate with the US dollar, using the import-related nominal exchange rate and CPIs for both the home country and the US.
- *RER$free*: a bilateral rate with the US dollar using the free/parallel nominal exchange rate and CPIs.

Annex C describes the procedure followed to construct the indices, and include charts and correlation matrices by country. With the exception of RER$free, the nominal exchange rate used is that applied to imports. The series *REERpm* and *REERppi* are based on our Haberger asymmetric definition, whereas the *REERcpi*, *RER$* and *RER$free* are based on the symmetric PPP definition.

Correlations among the various indices and their trends show that the behaviour of the REERppi series closely resembles that of REERcpi, so we only include the latter for the subsequent analysis, and any findings can also be extrapolated to the former. Meanwhile, the series constructed with the free/parallel nominal exchange rate, although by nature more volatile, tend to have similar long-term trends as the other variants, both by sub-periods and overall, and will not be considered further. The following charts show both REER series by country (all in logs):

[18] Floating arrangements – with convertible currencies - were rarely implemented, featuring only in the last decade of the century, with the adoption of inflation targeting. See Table A1 for a an outline of exchange rate regimes and inflation in each country.

[19] These series will soon be available in electronic format in the Oxford Latin American Economic History Database (OxLAD): http://oxlad.qeh.ox.ac.uk.

Chart 1

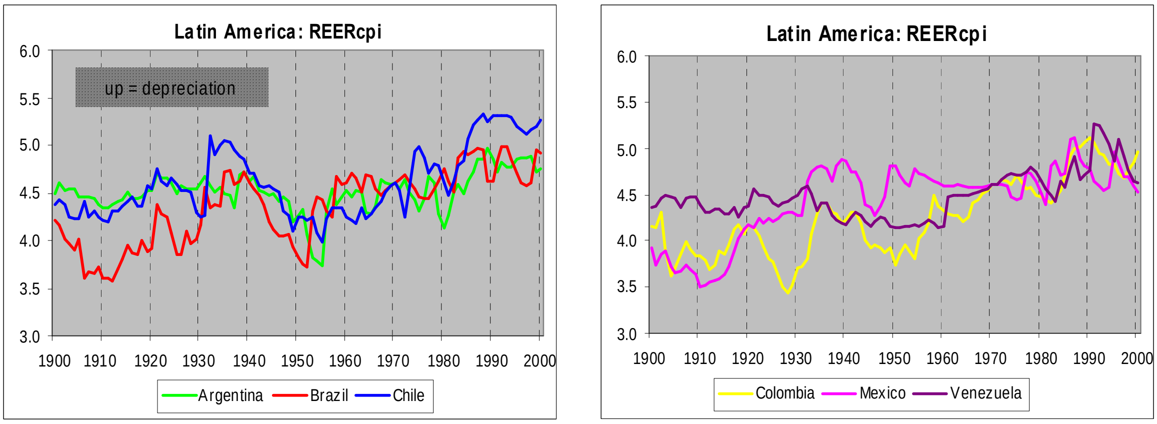
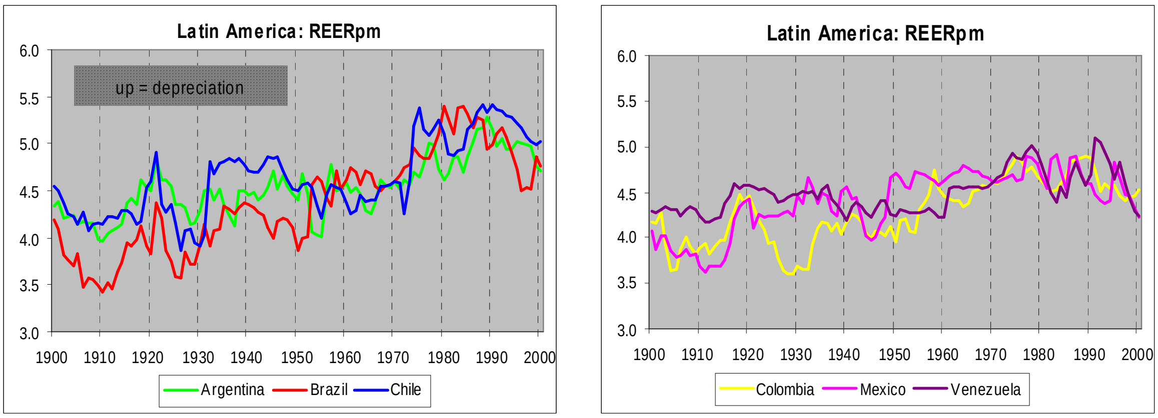


Chart 2



These series are the core material for the remainder of the paper. We start by looking at some basic time series characteristics.

III. Patterns in Real Exchange Rates in LA6 over the Century

In this section we compare three RER variants (two multilateral rates and one bilateral) for each of the LA6 countries, based on three main statistical measures: trends; volatility; and correlations. Trend values – which represent annual rates of growth - are estimated by fitting a linear trend plus a constant to each of the variables. Volatility is measured by the coefficients of variation over a period. And correlations are estimated for paired series within a given country, or between countries.

We include results for the whole century, as well as three sub-periods. These are defined according to two significant dates for the international monetary system: the 1929 Crash and the end of the Bretton Woods system in 1971, marking the beginning of floating exchange rate regimes for the principal currencies in world markets. Another defining feature of the third period is the increase in the price – and volatility – of oil after the OPEC oil embargo of 1973. In terms of the LA6 economies, the dates chosen define three periods that roughly coincide with the first three decades of export-led growth, predominantly under the gold or gold-exchange standard; the middle period marked by the ISI strategy, mostly under fixed or multiple exchange rate regimes; and the return to export-led growth in the last three decades of the century, with more mixed exchange rate regimes.

Trends and volatility

We begin by comparing the initial and final positions of the RER measures (Table 1). Except in the case of Brazil, the ratio 2000 to 1900 values depends on the measure used, particularly regarding REERcpi and REERpm. Argentina and Venezuela are the two cases where the initial and final points are closer - with a higher level in 2000.[20] The symmetric measures for the remaining countries show, on average, a 20% real depreciation (i.e., a ratio close to 1.2).

Table 1: Real multilateral exchange rates, start-to-end ratios

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
			1900-2000			
REERcpi	1.04	1.21	1.20	1.17	1.18	1.05
REERpm	1.09	1.20	1.13	1.07	1.06	0.99
RER$cpi	1.10	1.22	1.19	1.19	1.19	1.08

Ratios are calculated using three-year averages at both ends of the period.

[20] This is somehow unexpected, as these two countries differ significantly in terms of their export sectors, inflationary history, and exchange rate policy. In Venezuela, the availability of oil rents played an important role in two respects. First, it provided a generous currency flow to maintain a stable fixed exchange rate that worked as a strong nominal anchor. And, second, it supplied the resources to pay for widespread subsidies in the production sector, alleviating pressures that otherwise would have led to an increase in consumer prices (Astorga, 2000).

Table 2 contains information about fluctuations and trends (additional charts per country are included in Annex C). As to the movements during the century, the 1900-1929 sub-period displays mixed trends with Colombia and Venezuela showing a flat or appreciating long-term trend, and a move towards depreciation in the remaining four countries. The middle period (1930-1970) is dominated by an appreciating trend in Argentina, Brazil, and Chile, and remains roughly flat in the rest of the LA6. Most countries experienced a strong depreciation at the start of the 1930s, followed by an appreciation drive that continued until the end of WWII or the mid 1950s. The disruptions to international trade and capital flows caused by the war forced the LA6 countries to implement exchange controls and multiple exchange rates to deal with severe balance of payment problems, generating pressures for currency overvaluation.

Table 2: Trends and volatility of RER variants
(Values in percentages. All underlying series are in logs)

		Argentina		Brazil		Chile		Colombia		Mexico		Venezuela	
		trend	*volatility*	trend	*volatility*	trend	*volatility*	trend	*volatility*	trend	*volatility*	trend	*volatility*
REERpm	**1900-1929**	1.0	*4.9*	0.2	*6.5*	-0.4	*4.8*	-0.2	*6.4*	1.8	*6.2*	1.0	*3.0*
	1930-1970	0.2	*3.9*	1.5	*5.9*	-0.6	*5.0*	1.8	*6.0*	1.0	*4.9*	0.2	*2.9*
	1971-2000	1.2	*4.1*	-0.5	*5.4*	1.3	*5.4*	-0.8	*3.3*	-1.1	*4.0*	-0.9	*4.6*
	1900-2000	0.8	*6.6*	1.6	*12.1*	1.0	*8.7*	0.9	*8.1*	0.9	*7.7*	0.4	*4.9*
REERcpi	**1900-1929**	0.4	*2.0*	0.6	*5.5*	1.1	*3.4*	-0.9	*5.8*	2.4	*7.2*	0.0	*1.7*
	1930-1970	-0.4	*5.3*	0.3	*6.4*	-1.4	*6.8*	0.9	*5.8*	-0.1	*3.4*	0.2	*3.6*
	1971-2000	1.7	*4.6*	1.0	*3.8*	2.8	*6.3*	1.3	*4.3*	0.5	*3.8*	1.0	*4.3*
	1900-2000	0.2	*4.7*	1.1	*9.0*	0.7	*7.9*	1.1	*9.6*	1.0	*9.1*	0.5	*5.6*
RER$cpi	**1900-1929**	1.1	*4.4*	1.4	*7.4*	1.7	*5.3*	-0.6	*5.5*	2.6	*8.2*	0.5	*3.0*
	1930-1970	-0.7	*6.1*	0.6	*6.4*	-1.1	*6.0*	0.9	*6.1*	0.0	*3.2*	0.3	*3.9*
	1971-2000	1.7	*5.2*	0.4	*4.6*	2.3	*6.1*	1.6	*4.8*	0.5	*3.9*	1.1	*4.0*
	1900-2000	0.3	*5.6*	1.1	*9.9*	0.7	*7.5*	1.2	*9.9*	1.0	*9.4*	0.5	*5.4*

Trend*: defined as the estimated trend coefficents from a linear regression ($y_t = a + bt + e_t$) over the corresponding period.*
The coefficients represent annual trend growth rates, in percentages.
*Volatility: defined as the coefficient of variation (σ/µ*100) of the series over the corresponding period.*

The period 1971-2000 displays a tendency towards real depreciation. This is consistent with evidence of a poor productivity record among the LA6 economies relative to the US (Astorga et al, 2003), indicating a negative HBS effect. The observed weakening in real exchange rates during the period also reflects the impact of trade liberalisation and increased dollar inflation. However, the oil exporting group

(Colombia, Mexico, and Venezuela) experienced real appreciation in the REERpm series - though amid high volatility.[21]

In general, the various real exchange rate indices have fluctuated significantly.[22] But the extent of the volatility differs across countries. Argentina and Venezuela show the lowest volatility whereas Colombia and Brazil have the highest. The period 1900-1929 appears as the one with the lowest volatility (except in Mexico due to the monetary and real consequences of the Revolution), which is consistent with the prevalence of the gold standard and a relatively more stable international environment.

In contrast, the period 1971-2000 tends to be the most volatile, reflecting the floating of the principal currencies of the world economy and recurrent balance of payments crises in the LA6 countries. Increased RER volatility was also fuelled by the temptation to delay devaluations and their inflationary consequences in the face of external and fiscal crisis. The commodity lottery explains why the REERpm series are more volatile for the oil importers (Argentina, Brazil, and Chile) than for the oil exporters.

Synchronicity among LA6

In this section we use information provided by correlation coefficients between countries to measure the degree of synchronicity in real exchange rate movements. Thus, high correlations indicate the dominance of common shocks, whereas poor synchronicity points to cases where country-specific factors were the main forces shaping the behaviour of relative prices. Table 3 presents intra-LA6 correlations for the two real multilateral rates for the whole century and for the three sub-periods. Country-pair correlation coefficients in each period are averaged out to reflect group

[21] This result is consistent with the findings of Wood (1991). He studied global patterns of real exchange rates over the period 1960-1984 in various categories of countries grouped according to their income levels. Relative to the developed country average, most developing countries experienced trend depreciation of their real exchange rates. However, the result for the oil-exporting developing economies was in the opposite direction.

[22] The level of real exchange rate volatility in most of the LA6 is significantly higher than that shown by a sample of European countries - including France, Norway, Spain, and the UK - for comparable series over the same period. For instance, according to our calculations, the coefficient of variation over the century for RER$cpi for UK is 3.45, followed by Norway with 4.83, France 4.87, and Spain 6.20.

behaviour. The table also includes a measure of dispersion of the correlation coefficients. Individual country-pair correlations can be found in Table C4 (for REERpm), Table C5 (for REERcpi), and Table C6 (for RER$cpi).

Table 3: Intra-LA6 Synchronicity of RER variants
(average correlations)

	REERpm		**REERcpi**		**RER$cpi**	
	mean	*dispersion*	mean	*dispersion*	mean	*dispersion*
1900-1929	0.56	*0.21*	0.42	*0.30*	0.61	*0.30*
1930-1970	0.08	*0.35*	0.30	*0.23*	0.33	*0.26*
1971-2000	0.24	*0.18*	0.45	*0.21*	0.44	*0.23*
1900-2000	0.66	*0.11*	0.56	*0.19*	0.60	*0.14*

Average*: average correlations between countries in the LA6 over each period.*
Dispersion: standard deviation on country-pair correlations.

Regarding the whole century, the REERpm displays a high degree of co-movements (an average value of 0.66). This result is driven by strong synchronicity among the economies of Argentina, Brazil, Chile, and Colombia. Meanwhile, the REERcpi shows a relatively lower aggregate correlation among the LA6 (0.56). Argentina exhibits a poor level of co-movement with Brazil and Mexico, dragging the average value down.

When looking at the sub-periods, the REERpm shows a high average correlation (0.56) with relatively low dispersion in the country-pair values in the first period. This is followed by a marked decline in the degree of synchronicity in the middle period – and increased dispersion. Argentina and Chile behave atypically, with little evidence of co-movement and, in some cases, with changes in opposite directions (e.g., against Brazil and Mexico). The period 1971-2000 displays a recovery in synchronicity (0.24), but reaching less than half the value recorded in the first period. The average correlation in the final period is undermined by negative coefficients between Brazil and Venezuela, and Chile and Mexico.

Meanwhile, the CPI-based indices show a similar U-shaped pattern of aggregate correlations across the three sub-periods, but with a more moderate fall in the 1930-

1970 period, and a stronger recovery in the final one. In this case the level of dispersion in country-pair coefficients across sub-periods also follows a U-shaped pattern. In terms of countries, Colombia and Venezuela show a poor degree of co-movements in the early period. The years 1930 to 1970 are characterised by low correlations with little dispersion between the country pairs. The final period is more mixed, with correlations between multilateral rates ranging from 0.81 between Colombia and Chile, to lack of correlation between Mexico and Venezuela (see Table C5).

There are several factors that can explain such patterns. Overall, a similar mix of trading partners meant that fluctuations in foreign currencies or external demand tended to have a synchronised impact. Over the century, the US and the UK were, on average, the origin of about half of all imports of our six LA economies, and represented a similar share of the destination of exports. Although, for the century as a whole, the US was the dominant trading partner and source of foreign investment for the LA6, prior to WWII, the economies of Argentina and, to a lesser extent, Brazil, had the UK as the main destination for exports (see Table C1).[23]

During the years prior to the 1929 Crash, the LA6 economies presented a similar model of integration to the world economy (exporters of commodities and importers of capital and manufactures from the main industrialised countries); they implemented economic policies according to the dictates of the gold standard; and they were exposed to two major external shocks (WWI and the 1920-21 Depression). These factors resulted in a growing commonality in their real exchange rate movements consistent with a high LA6 correlation average.[24]

The 1930s constituted a watershed for the LA6 economies, with their response to the crisis being conditioned by the degree of policy autonomy and the commodity lottery (Díaz-Alejandro, 1984). In general, this situation, compounded by the disruptions of WWII, set the countries on course for an accelerated process of import-substitution

[23] The triangular structure of foreign trade and capital movements made those economies particularly vulnerable to the difficulties of the British economy (O'Connell, 1984).

[24] Catao & Solomou (2003) report similar evidence for a wider sample of countries in the periphery over the period 1890-1913.

industrialisation. The closure of international trade gave a more prominent role to internal factors (likely to be country specific) underpinning RER movements. And different speeds and reach of import substitution among countries (more in Argentina and Brazil, and significantly less in Venezuela) introduced further variations to the import mix. This is reflected in a low aggregate correlation and high dispersion.

Finally, the return to export-led growth and more open economies across the region during the third period benefited the degree of synchronicity. However, the roller-coaster of oil prices post 1973, introduced an important source of asymmetry in the formation of relative prices within oil-exporters and oil importers. This partly accounts for the weaker average correlation displayed by the REERpm compared with the two symmetric measures.

It is also interesting to note the poor correlation between the multilateral indices of Argentina and Brazil in the sub-period 1971-2000 (see Tables C4 and C5). This is not surprising since it is the consequence of increased trade integration,[25] which in multilateral indices - due to the way the indices are constructed - translates into a reduction in correlation between the two countries. In this case, an RER depreciation in one country mirrors an appreciation drive in the other, thus partly offsetting the effect of co-movements relative to third countries in the aggregate index. When this mirror effect is not present, the correlation between both countries rises from 0.31 to 0.52 (see correlation matrix for the RER$cpi in Table C6).

IV. Mean Reversion

One aspect of special relevance for this work is the mean reversing property of the series. The empirical literature dealing with the testing for long-run PPP usually relies on the augmented Dickey-Fuller test (ADF) for unit root in the process driving the real exchange rate. The rejection of the null hypothesis that a time series follows a random walk – the archetypical non-mean reverting process – is taken as evidence of mean reversion (Taylor, 2003). We characterise the behaviour of the real exchange rate, distinguishing among four cases of interest:

[25] Trade between Argentina and Brazil rose from US$2.1bn in 1990 to US$13.4bn in 2000 (CEI).

a) Stationary process around a constant mean: this supports the assertion that purchasing power parity (PPP) holds in the long run.
b) Stationary process after allowing for structural breaks in the series (quasi-PPP).
c) Stationary process around a trend (or a breaking trend), in which case the strict PPP does not hold.
d) Random walk/unit root: in this case the RER does not follow a predictable pattern, and there is no tendency to fluctuate around a stable underlying path.

The application of the unit root tests - ADF and Phillips-Perron (PP) - to our REER series in levels (logs) can not reject the null hypothesis in any of the cases, with the exception of Venezuela's REERpm at the 10% level (see Table D1). This indicates that the series in levels are non-mean reverting; a result that is at odds with the message from recent studies with long-span data. The failure to reject the unit-root hypothesis can be due to the presence of trends or structural breaks in the series. Once a simple linear trend is included, the unit root test performed over the de-trended series (e.g., the residuals of the regression with a time trend and a constant) still rejects the null hypothesis in most cases at the 5% level (see Table D1 for the exceptions).

But we still need to deal with the possibility of structural breaks in the series, before concluding that they are non-stationary. A central message of the work by Perron (1989, 1990) is that, when the true process involves such breaks, the power of such unit root tests can be dramatically reduced. We follow the two-stage procedure to test for non-stationarity in series with breaks in the mean or in the trend proposed by Perron (1994, 2006). See Annex D for a description of the procedure. We use "additive outlier models" (AOM) because they allow for a joint change in the trend without a break, and in general offer a good description of our series. In the first step, the trend function of the series is estimated and removed from the original series via regressions derived from Models (AO-0) to (AO-C). The second step tests for unit roots in the resulting residuals. But first we need to identify the potential break points.

Identification of structural breaks

In the last ten years or so there has been significant research focusing in methods to find date breaks endogenously (i.e., not imposed on the data or taken as known) and, more recently, in refining tests and procedures to deal with multiple structural breaks.[26] We adopt the methodology proposed by Zivot and Andrews (1992) to determine endogenously structural breaks. In this procedure a test statistic is calculated in each period, allowing for the possibility of breaks in the intercept, the slope, or both. The test associates the most negative value with the date of a break point. If this minimum is below (i.e. higher in absolute value) a given critical value, it implies that the non-stationarity of the series is due to the presence of a structural break.[27] In order to identify potential multiple break points, we follow a sequential procedure on the lines suggested by Bai & Perron (1998). However, the power of the test declines sharply once the sample is subdivided.

Table 4 summarises the result of testing for structural breaks for both REERcpi and the REERpm (see next page). The first column gives information about the years where the Z&A procedure identifies a minimum. The next column presents the type of break (ie. in the mean, the trend, or both) together with an indication of the rejection of the null hypothesis.[28]

When applying the Z&A test to the REERcpi series the null hypothesis of unit root is rejected at the 10% level or lower in eleven cases, involving five countries (Argentina, Brazil, Colombia, Mexico, and Venezuela). The test values for Chile are not strong enough to reject the null at the 10% level of significance. However, the probability of not rejecting the unit root null when it is false is high, even with a long span of data. For instance, Lothian & Taylor report that with a century of data there would be less than a fifty-fifty chance of rejecting the unit-root hypothesis when in

[26] Zivot & Andrews (1992) endogenised the break date and Banergee et al (1992) used recursive methods to identify structural breaks. Later Bai (1997) and Bai & Perron (1998) proposed a technique that enables one to estimate breaks either simultaneously or sequentially in cases of non-trending and regime-wise stationary data. And more recently Kejriwal & Perron (2006) propose a testing procedure to deal with multiple structural changes in both stationary and non-stationary series.

[27] We use a programme developed by G. Trujillo (2006) in E-views to implement the Zivot & Andrew test. We tried an alternative programme developed by Kit Baum (2004) in Stata language to test a sample of our series and found minimum values around similar dates.

[28] Critical values for additive outlier models are taken from Perron (1990) for model AO-B (change in slope) and Perron and Vogelsang (1993) for models AO-0 and AO-1 (intercept) and AO-C (intercept and slope).

fact the process is mean reverting.[29] For Chile's REERcpi, we decide to include a breakpoint in the mean in 1945, where the test is close to the critical value at 10% of significance.

Table 4: Indentification of break points, 1900-2005
Zivot & Andrews testing procedure

	REERcpi			REERpm	
	year	*type & t-stat*		*year*	*type & t-stat*
Argentina	1952	M&T ***		1953	M&T **
	1955/85	T **		1976/85	T **
	1985	M ***		1985	M **
Brazil	1944	T **		1980	M&T **
	1944	M&T		1992	T *
	1944	M		1992	M
Chile	1945	M		1974	M **
	1947	M&T		1974	T **
	1974	T		1974	M&T
Colombia	1924	M*		1956	M
	1958	T **		1955	T **
	1957	M&T *		1956	M&T *
Mexico	1917	M *		1917 (1)	M *
	1917	M&T *		1977	
	1932	T **		1989	T *
Venezuela	1937	M		1961	M
	1961	T *		1961	T *
	1961	M&T		1972	M&T

(1) sample 1900-1988.
M: break in the mean; T = break in the trend; M&T= break in the mean and trend.
*, **, & *** indicate that the critical value is rejected at the 10%, 5%, and 1% levels, respectively.

Regarding the REERpm series, the null is rejected at the 10% level or lower in twelve cases involving all countries. We use this information in order to specify AOM for each series in each of the LA6 countries in the following section. But prior to this we add some discussion on the economic significant of the key breakpoints by relating them to salient economic events or turning points in economic policy.

[29] In the presence of this level of type II error, the researcher needs to take a view on whether to make allowances for a break. This decision involves giving more weight to one of the two competing conceptions of the nature of the macroeconomic series. Under a view that favours non-stationarity, lasting shocks to the series can be interpreted as low probability realisations of a given data-generating process. On the other hand, under the belief that the world is more akin to stationary processes, a sudden and lasting move is seen as an alteration in the data generation process, i.e., a structural break rather than a low-probability event.

Breaks linked to the trade openness cycle

Many of the breaks are in tune with the openness cycle linked to the countries' growth and development strategies. For instance, four of the breaks occurred in a period when there was a deepening of the ISI strategy initiated in the 1930s and 1940s. *Argentina* experienced a marked depreciation in its real exchange rate in the period 1952-1955, which was followed by a major turning point in 1955 with the coup d'état against General Peron. This event made possible the beginning of a new economic policy regime directed primarily at liberalising trade and addressing some major structural weakness of the ISI.[30]

In *Brazil*, 1944 signifies the run up to the introduction of exchange and import controls of the post war period under the Dutra government that would remain in place for the next two decades.[31] Parity was maintained during the period 1947 to 1952 whilst inflation in Brazil was twice that of the US, resulting in an escalating overvaluation. The policy was unsustainable, culminating in the exchange collapse of 1952 and the subsequent reform of the exchange rate regime in 1953.

Meanwhile, in *Chile* the years around 1945 are associated with the introduction of a system of multiple exchange rates aimed at supporting the ISI policy, the main elements of which would remain in place until the end of 1973. A multiple exchange regime had been adopted in 1936 largely affecting the export sector, but it was only in 1940 that differentiated rates were created to manage a foreign currency budget for imports. This decision brought about a prolonged period of currency overvaluation.

And in *Colombia* 1957 coincides with the implementation of a wide-ranging reform of the exchange control system previously introduced in 1932 (Romero, 2005). This resulted in a cumulative 61% currency devaluation between 1956 and 1958. The external situation deteriorated further in the 1960s, with a sustained fall in coffee prices, high inflation and rising fiscal deficit. This triggered another devaluation of the peso in 1962, this time of 26%.

[30] Richaud et al (2003) in their study on Argentina over the period 1915-1995 found evidence of a structural break in 1955, based on information provided by Chow breakpoint tests and the analysis of parameter stability.

[31] Our main source for economic policy in Brazil throughout the century is Abreu (1990).

Finally, *Mexico* also experienced a shift from outward-looking to inward-looking policies in the aftermath of the 1929 Crash (Cárdenas, 2000). The break in 1932 is associated with the government's decision to leave the peso to float freely after a monetary reform in March that year. In November 1933 the peso was fixed to the dollar at a parity that implied a 35% depreciation relative to February 1932, and 67% relative to 1929. This parity remained until 1938, despite the abandonment of the gold standard by the US in 1934. As to the significance of the year 1989 (only for REERpm), this coincides with the introduction of major structural reforms that paved the way for Mexico's incorporation into NAFTA in 1995.

Externally-driven breaks

Other discontinuities tend to occur primarily in response to specific external events. This is the case of *Brazil* in 1980 (for REERpm), when a two-fold increase in international oil prices, coupled with hikes in international interest rates and the drying up of capital inflows created a severe balance of payments disequilibrium that forced the government to introduce an adjustment package that produced the first fall in economic growth in the post-war period. Despite these contractionary measures, the crisis set in motion a process of hyperinflation that would dominate the 1980s. The acceleration in prices and a succession of failed stabilisation programmes resulted in weaker and more volatile real exchange rates – particularly in the REERpm measure.

And in *Venezuela* the period 1956-1964 represented the first boom-bust episode since the large scale exploitation of oil began in the mid-1920s. The boom was triggered by the closure of the Suez Canal and the subsequent increase in oil prices. The re-opening of the Suez Canal in 1958 and a subsequent fall in international oil prices, together with a deterioration in the investment climate following the inauguration of a new democratic government with strong nationalistic views, resulted in a simultaneous balance of payment and fiscal crisis. The government was forced to implement an adjustment package and a multiple exchange rate regime in early 1961. By early 1964 the country had returned to a unified fixed regime after a 35% cumulative devaluation (Hausmann, 1990).

Finally, there are a couple of breaks that can be attributed to the interaction between external forces and political events. In *Chile* we found evidence of a break circa 1974 (REERpm series only), where a tariff reduction and worsening terms of trade required a real depreciation to maintain external equilibrium.[32] This decision was taken in the aftermath of the military coup against the Allende government. This event brought about a radical turn in the country's development strategy towards an open, privatised economy free from state intervention. The structural adjustment that followed caused a period of great economic instability, which was aggravated by the 1974 oil shock (French-Davis et al, 2000).

And in *Mexico* a monetary reform in 1917 re-established the gold standard (Cárdenas & Manns, 1987), putting an end to a period of currency inconvertibility that started in 1913 with the intensification of the political upheaval. This brought about a recession and set in motion a process of deflation that dominated the economy for the next 10 years or so. This, combined with inflation in the US, and a fixed exchange rate regime brought about a sustained process of real depreciation in Mexico that would prevail for the next two decades.

Empirical results

In this section we propose a set of suitable models for the LA6 group and implement Perron's two-stage procedure to test for non-stationarity. The results are summarised in Table 5 for REERcpi. See Table D2 in Annex D for results on REERpm. Columns 1 and 2 give the model to be estimated and the breakpoint dates. When more than one break is included, we list them in chronological order. For instance, in Table 5, Brazil's model OA-B&C, 1914 & 1944 indicates the inclusion of a trend break in 1914[33] and a simultaneous break in the mean and trend in 1944. Columns 3 to 6 present key estimated parameters of the regressions: $\hat{\beta}$ is the estimate of the initial

[32] Edwards (1989, 129-132) also identified a case for a structural break around 1974 in his analysis of the Chilean real exchange rate over the period 1963-1983.

[33] Although we did not find significant evidence of a point break circa 1914, the date is a turning point in the Brazilian real exchange rate, signifying the abandonment of the gold standard followed by a prolonged period of currency inconvertibility – plus a sharp depreciation during the 1920-21 Depression (Abreu, 1990). Catão and Solomou (2003) show a roughly trend-less real exchange rate for Brazil during the period 1870-1913, with appreciating pressures in the first decade of the XXth century (due to the rubber boom and strong capital inflows).

(pre-break) slope of the trend function; $\hat{\theta}_1$ and $\hat{\theta}_2$ are estimates of the change in the intercept of the trend function; and $\hat{\gamma}_1$ and $\hat{\gamma}_2$ are estimates of the change in the slope of the trend function (post first break).[34] In Column 6 we report the standard error of the regression.

Table 5: Perron stationarity test fot REERcpi

period 1900-2005			First stage						Second stage	
	(1) *model*	(2) *Tb*	(3) $\hat{\beta}$	(4a) $\hat{\theta}_1$	(4b) $\hat{\theta}_2$	(5a) $\hat{\gamma}_1$	(5b) $\hat{\gamma}_2$	(6) *SE*	(7) $\hat{\alpha}$	(8) $t_{\hat{\alpha}}$ (ADF)
ARG	AO-B	1952	**-0.006**			**0.018**		*0.187*		
	AO-C	1952	0.000	**-0.358**		**0.017**		*0.164*	**0.62**	-3.25**
	AO-B	1955	**-0.005**			**0.019**		*0.182*		
	AO-C&B	1952 &1985	0.000	**-0.306**		**0.014**	0.011	*0.162*		
BRA	AO-B	1944	**0.012**			-0.002		*0.235*		
	AO-C	1944	**0.020**	**-0.409**		**-0.006**		*0.213*	**0.64**	-3.80***
	AO-B&C	1914&1944	**-0.020**		**-0.587**	**0.053**	**-0.020**	*0.193*	**0.59**	-3.79***
	AO-C	1953	**0.009**	0.120		0.000		*0.235*		
CHI	AO-A	1945	**0.020**	**-0.853**				*0.2*	**0.56**	-4.08***
	AO-C	1947	**0.012**	**-0.778**		**0.012**		*0.182*		
COL	AO-B	1958	**0.006**			**0.015**		*0.211*		
	AO-C	1957	0.002	**0.263**		**0.014**		*0.200*	**0.72**	-4.38***
MEX	AO-B	1917	**0.044**	**-0.037**				*0.238*		
	AO-C	1932	**0.024**	**0.327**	**-0.023**			*0.166*		
	AO-0&0	1917&1932	0.001	**0.502**	**0.442**			*0.149*	**0.59**	-4.0***
	AO-B&C	1917&1932	-0.001	**0.529**	**0.454**	0.002		*0.115*		
VEN	AO-B	1961	-0.002			**0.017**		*0.152*		
	AO-C	1961	**-0.005**	**0.322**		**0.014**		*0.130*	**0.70**	-3.18**

Columns 3-5: estimates in **bold** are significant at least at the 5% level.
SE : standard error of the regression.
(*), (**), and (***) indicate that the critical value is rejected at the 10%, 5%, and 1% levels, respectively.

Finally, columns 7 and 8 display information related to the second stage of the testing procedure: $\hat{\alpha}$ is the estimate of the autoregressive coefficient (see equation D.2 in Annex D), and $t_{\hat{\alpha}}$ is the associated t-statistic – we use the ADF test - for testing that α =1.[35] In deciding on which particular specification to choose for each country (shaded values), we also assess the SE of the regression for different possibilities of combinations for break points. In general, we favour those specifications that

[34] Because the REER variables are in logs, the trend coefficients indicate annual rates of growth. In the presence of a break in the trend, the annual rate of growth in the post-break period results from adding up the initial trend coefficient $\hat{\beta}$ and the $\hat{\gamma}$ s estimates. For example, in the case of Argentina REERcpi’s AO-B (1952) model, the annual trend rate of growth up to 1952 is estimated at -0.6%. But after 1952, it changes to 0.9% (-0.6% +1.8%).

[35] We used a lag parameter of four for the sum of the autoregressive first differences, and a lag of two for the trend dummies (only necessary in models A and C).

minimises the SE of the regressions. But if the difference is small, we opt for the simplest specification (i.e., with the minimal number of breaks).

All adjusted series are stationary around a trend after allowing for at least one-time structural change. This evidence indicates mean reversion in the adjusted series. The inclusion of trends and structural breaks are proxying for movements or shifts in the RER fundamentals. Charts D1 (REERcpi) and Charts D2 (REERpm) depict the fitted trends and the adjusted series.

Table 6 presents information about the speed of mean reversion in our adjusted series. First estimates for the autocorrelation coefficients of the de-trended series are presented with the corresponding half-time values for each of the REER series. The lower part includes information about the series after making allowances for trends and breaks.[36]

Table 6: Speed of mean reversion

1900-2005	**Argentina**	**Brazil**	**Chile**	**Colombia**	**Mexico**	**Venezuela**
De-trended series						
REERcpi						
alpha	0.86	**0.76**	0.90	**0.82**	0.91	0.88
half-life	*4.6*	*2.5*	*6.5*	*3.5*	*7.0*	*5.4*
REERpm						
alpha	**0.64**	**0.80**	**0.80**	0.83	0.88	0.84
half-life	*1.6*	*3.0*	*3.1*	*3.8*	*5.4*	*4.1*
Series de-trended and corrected for structural breaks						
REERcpi						
alpha	**0.62**	**0.59**	**0.56**	**0.72**	**0.59**	**0.70**
half-life	*1.4*	*1.3*	*1.2*	*2.1*	*1.3*	*1.9*
REERpm						
alpha	**0.43**	**0.54**	**0.72**	**0.68**	**0.46**	**0.75**
half-life	*0.8*	*1.1*	*2.1*	*1.8*	*0.9*	*2.4*

Alpha: autocorrelation coeficient.
The half life of the process is measured in years.
*Values in **bold** are series where the unit root is rejected at the 10% level or lower.*

[36] To calculate the half-time of the process of mean reversion in the second case we use the autocorrelation estimates $\hat{\alpha}$ reported in Tables 5 and 6.

The half-life of the de-trended REERcpi series ranges from 2.5 years in Brazil to 7 years in Mexico in the case of REERcpi; and from 1.6 years in Argentina to 5.4 years in Mexico for the REERpm series. Note that these half-life ranges are similar to those found in more advanced economies, but with the crucial difference that the former are obtained after de-trending the original series. Thus, this can be interpreted as a required correction due to the development process – primarily real-side effects, and may give an indication of the size of the "survivors" bias.

After adjustments for breaks, the half-life values drop significantly, now with the REERcpi values ranging from 1.2 years in Chile to 2.1 years in Colombia; and the REERpm's from less than one year in Argentina to 2.4 years in Venezuela. This second set of estimates is supposed to be "free" of the impact of major discontinuities (e.g., related to external shocks with permanent effects) or exchange rate or trade regime changes. It is likely that the relatively high level of persistence shown by the LA6 reflects a tendency towards prolonged periods of currency overvaluation - made possible by the prevalence of fixed or multiple exchange rate regimes and exchange controls - followed by drastic devaluation-driven adjustment episodes.

V. Conclusions

Our analysis of real multilateral exchange rates shows a tendency to real depreciation in the long term, the extent of which partly depends on the measure used. The beginning-to-end (1900-2000) comparison based on the symmetric multilateral indices shows little depreciation in Argentina and Venezuela. However, for the remaining four countries there is, on average, a 20% real depreciation. Meanwhile, the asymmetric measure based on border import values shows on average a 10% depreciation by the end of the last century. When looking at trends within the period, the last three decades of the century tend to be dominated by depreciating trends.

Overall, the trending behaviour points to the action of real effects in shaping the equilibrium position. That the end result is a more depreciated real exchange rate despite a process of economic development is somehow surprising, but consistent with prevailing economic theory. One likely explanation is that the potential for real appreciation in these countries was not realised due to a poor productivity performance (a negative BSH effect) that outweighed positive wealth effects (e.g. resource discoveries) and sustained foreign direct investment.

Despite differences in exchange rate regimes, inflationary experience, and the commodity lottery, there is evidence of a moderate level of intra-country synchronicity in real exchange rates, particularly among Argentina, Brazil, Colombia, and Chile. This partly reflects the workings of common external shocks, and similarities in the integration of the Latin American countries to the world economy. When looking at the sub-periods, there is a U-shaped pattern with a relatively high average correlation in the period 1900-1929, followed by a marked decline in the degree of synchronicity in the middle period, and a recovery in the last three decades of the century. This pattern is consistent with the trade opening cycle.

For the LA6 we could not reject the null hypothesis of unit root in the original series in levels, which indicates a very slow process of mean reversion – if any. We showed that the initial non-stationarity can be removed by making allowances for trends and structural breaks. And that the half life of the process of the adjusted series ranges from 0.8 to 2.5 years - compared to a 1.6 to 7 years for the series that have only been de-trended. The apparent difficulties of the LA6 countries in adjusting their real exchange rates – even after accounting from trends - open further questions as to what extent this reflects structural rigidities in reallocating resources after an external shock, or delays in policy response owing to, for example, constraints on real wages. Looking at these factors may also help to account for intra-country differences in the speed of mean reversion.

The failure to reject the unit root hypothesis in the series in levels has important practical implications for the construction of PPP benchmarks for international income comparisons, and for the use of PPP exchange rate estimates to determine the degree of misalignment of the nominal exchange rate and the appropriate policy response (Sarno and Taylor, 2002). The presence of non-stationarity, for instance, undermines the use of a constant PPP benchmark in long-span studies involving these countries (Astorga et al, 2006), or a wider sample of economies including the LA6 (Prados de la Escosura, 2004; Maddison, 1989). When comparing GDP per-capita at PPP values, the weakening of the RER in the closing decades of the century suggests that the LA6 growth record might be worse than that shown by estimates using a constant PPP benchmark.

As part of our ongoing research programme on Latin American long-run economic development, we are studying the role of fundamentals - including relative productivities, terms of trade, and trade openness - using multivariate models and an error-correction mechanism specification (results to be published in a forthcoming paper). This approach gives additional and richer information to explain fluctuations – both originated in currency changes and movements in fundamentals - and long-term patterns in the real exchange rate.

ANNEX A: Exchange Rate Regimes and Inflation

Table A1: Key developments related to the foreign exchange regime and inflation, 1900-1950

	Argentina		Brazil		Chile		Colombia		Mexico		Venezuela		World events
	Regime	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	
1900	gold		inconver.				inconver.		bimetalic				
1901		low		deflation		low		hyper		moderate		low	
1902													
1903				low						low			
1904								high					
1905							gold	deflation	gold				
1906			gold										
1907						moderate							
1908								low					
1909						low							
1910													
1911													
1912													
1913								deflation	inconvert.	high			
1914	off gold		off gold		off gold		off gold				off gold		WWI
1915			Inconvertible							hyper			WWI
1916			(stable)					low					WWI
1917		moderate		low					gold	deflation			WWI
1918													WWI
1919	de-facto gold		Fluctuating			moderate						moderate	WWI
1920			(incomvertible)										Depression
1921		deflation				low			gold formal				Depression
1922												low	
1923				moderate							gold		
1924							gold						
1925					gold								
1926				deflation									
1927	back gold												
1928			back gold										
1929	drop gold							deflation					29 Crash
1930	inconver.										drop gold		Great Dep
1931	exch. controls		drop gold		drop gold		drop gold		drop gold				
1932							Ex. controls						
1933			multiple		exch controls				fixed	low	floating		
1934	official+free			low									
1935		low					fixed						
1936					mult X			low					
1937													
1938			fixed								fixed		
1939	multiple		multiple										WWII
1940					multiple + M	moderate	multiple for M						WWII
1941													WWII
1942				moderate						moderate			WWII
1943								moderate					WWII
1944													WWII
1945		moderate					multiple						
1946			fixed										start Bretton Woods
1947				low						low			
1948							multiple						
1949													
1950													

Fixed: *also includes gold stadard and bimetalic.*
Multiple: *focus on the introduction of multiple rates to import flows.*
Other: *includes inconvertibility periods, pegs, crawling pegs, pre-announced pegs, and not specified.*
Inflation categories: *deflation < 0% ; low 0%-10% ; moderate 10%-30% ; high: 30%-100% ; hyper > 100%.*

Table A1: Key developments related to the foreign exchange regime and inflation, 1950-2000

	Argentina		Brazil		Chile		Colombia		Mexico		Venezuela		World events
	Regime	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	*Regime*	*Inflation*	
1950									fixed		fixed		
1951				moderate				low					
1952													
1953		low	multiple										
1954						high							
1955		moderate											
1956					dual								
1957													
1958		high											
1959													
1960		moderate				moderate							
1961											multiple		
1962			multiple	high									
1963						high		moderate					
1964	peg				dual						multiple		
1965					crawling	moderate					fixed		
1966													
1967			multiple				crawling	low					
1968			mini dev	moderate			(single rate)						
1969						high							
1970													
1971	dual	high			crawling			moderate					end Bretton Woods
1972						hyper							
1973										moderate			Oil shock
1974					crawling								
1975		hyper											
1976				high									
1977					crawling								
1978					tablita	high							
1979	tablita		mini dev		tablita								
1980			gradualism		peg								
1981	dual			hyper	peg	moderate							
1982			gradualism		dual				dual	high			Debt crisis
1983			stabil. plans								multiple		
1984													
1985													
1986													
1987												high	
1988													
1989										moderate	floating		
1990													
1991	floating												
1992	board	moderate			dual				crawling		crawling		
1993			stabil. plans		crawling						crawling		
1994		low	dual				crawling				multiple		
1995				high		low			floating				
1996				moderate							bands		
1997				low									Asian Crisis
1998												moderate	
1999		deflation	floating		floating			low					
2000							floating						

Fixed*: also includes gold stadard and bimetalic.*
Multiple*: focus on the introduction of multiple rates to import flows.*
Other*: includes inconvertibility periods, pegs, crawling pegs, pre-announced pegs, and not specified.*
Inflation categories*: deflation < 0% ; low 0%-10% ; moderate 10%-30% ; high: 30%-100% ; hyper > 100%.*

ANNEX B: Real Exchange Rate Definitions

The Harold-Balassa-Samuelson effect

The PPP definition is given by the following expression:

(B.1) $RER_{ppp} = E\frac{P_C^*}{P_C}$

where E stands for the nominal exchange rate. P_C is the price level at home and abroad, with * denoting foreign (the comparator country).

Expression (B.1) can be decomposed further to illustrate the HBS effect. After applying logarithmic transformation we obtain (variables in logs are denoted in lower case letters):

(B.2) $r_{PPP} = e + p_C^* - p_C$

We use geometrically weighted averages to disaggregate the CPI at home and abroad.

$p_C = \alpha p_T + (1-\alpha)p_N$

$p_C^* = \alpha^* p_T^* + (1-\alpha^*)p_N^*$

where: p_T, p_T^* = the logarithm of the price of tradable goods (home/foreign)

p_N, p_N^* = the logarithm of the price of non-tradable goods (home/foreign)

α, α^* = expenditure share on tradable goods (home/foreign)

And after substituting both price expressions into (B.2) we obtain:

(B.3) $r_{PPP} = (e + p_T^* - p_T) + (1-\alpha)(p_T - p_N) - (1-\alpha)(p_T^* - p_N^*)$

The first term of the RHD refers to the terms of trade between home and foreign; the second measures relative prices at home; and the third relative prices in the foreign country. If we assume that arbitrage ensures that traded goods sell for the same price across markets ($P_T = P_T^*$) and that the expenditure shares are equal ($\alpha = \alpha^*$), then (B.3) becomes:

(B.4) $r_{PPP} = (1-\alpha)[(p_T - p_N) - (p_T^* - p_N^*)]$

Under the conditions where labour is the only factor of production and each good requires a fixed amount of labour, prices can be expressed as the ratio between nominal wages (which are equalised across sectors within the economy) and the average product of labour - the inverse of the labour unit requirement (Lafrance & Schembri, 2000).

$P_i = W / L_i$ with i=T,N

And in log terms:

(B.5) $p_i = w - l_i$

After substituting (B.5) into (B.4), we obtain:

(B.6) $r_{PPP} = (1-\alpha)[(l_T^* - l_T) - (l_N^* - l_N)]$

Abstracting from changes in the average product of labour in the non-tradable sector, equation (B.6) implies that movements in the real exchange rate are a function of the relative importance of the non-tradable good sector ($(1-\alpha)$, also reflecting openness to trade, and the differences in productivity growth in the tradable sector (e.g. manufacturing). This underpins the main prediction of the HBS formulation, i.e., that relative high productivity in the tradable sector should result in an appreciation of the real exchange rate (r_{PPP} declines/appreciates if $l_T > l_T^*$).

Expressions linking the three definitions

In this section we develop expressions to link the three definitions. In order to simplify the algebra we abstract from the distinction between ^ and *. Assuming that the law of one price holds for tradable goods and making allowance for taxes on trade (t, $t \geq 0$), the RER_{DE} can be expressed as:

$$RER_{DE} = \frac{P_T}{P_N} = \frac{E(1+t)P_T^*}{P_N}$$

We assume that the country operates under a fixed exchange rate regime, so that E can be set equal to1.[37]

(B.7) $RER_{DE} = \dfrac{(1+t)P_T^*}{P_N}$

Taking logs on both sides we obtain (as before, lower case denote logged values):

(B.8) $r_{DE} = (1+t)\, p_T^* - p_N$

The next step is to use geometrically weighted averages to disaggregate the CPI (from the expression $P_C = P_T^{\alpha} P_N^{(1-\alpha)}$) and the border price of tradable goods ($P_T^* = P_M^{*\beta} P_X^{*(1-\beta)}$). After taking logarithms on both sides and re-arranging:

(B.9)
$$\begin{aligned} p_N &= [\, p_C - \alpha(1+t)p_T^* + (1-\alpha)]/(1-\alpha) \\ p_T^* &= \beta\ p_M^* + (1-\beta)\, p_X^* = p_M^* + (1-\beta)\tau \end{aligned}$$

Where α is the share of tradable goods in the home country's commodity basket; p_M^* and p_X^* are the border price of imports and exports (in logs) respectively, β is the share of import goods in the countries traded goods, and τ is the logged terms of trade (p_X^* - p_M^*). Then substitute (B.9) into (B.8) and solve in terms of p_C and p_M^*:

(B.10) $r_{DE} = \dfrac{(1+t)(p_M^* - p_C) + tp_C + (1+t)(1-\beta)\tau}{(1-\alpha)}$

Define the logarithm of the real import exchange rate (based on our Harberger definition) as:

[37] This is a reasonable assumption for our sample of countries, which, on average, were under some sort of fixed exchange rate regime more than 60% of the time over the last century.

(B.11) $r_H = p_M^* - p_C$

And substitute (B.11) into (B.10) to obtain a relationship between both RERs:

(B.12) $r_{DE} = \dfrac{(1+t)r_H + tp_C + (1+t)(1-\beta)\tau}{(1-\alpha)}$

So that both relative prices move in the same direction, for given values of the parameters. And if it is assumed further that there are no taxes on trade (t = 0), B.12 becomes:

(B.13) $r_{DE} = \dfrac{r_H + (1-\beta)\tau}{(1-\alpha)}$

(which equation 4 in the main text)

The main difference between both RER concepts in (B.13) is due to the added impact of a change in the terms of trade in the price of tradables (priced in domestic currency).

And to the extent that the export sector is an enclave and its production has little impact in the formation of tradable prices in the home country (that its, β tend to zero),[38] expression (B.13) becomes:

$$r_{DE} = \frac{r_H}{(1-\alpha)}$$

Next we take from Edwards (1989, p.6) the expression that links the DE concept with that of PPP. As previously, assuming that the law of one price holds for tradable goods, that the nominal exchange rate is fixed, and that there are no taxes on trade, we have the following expression:

(B.14) $r_{DE} = [1/(1-\alpha)]r_{ppp} + [(1-\delta)/(1-\alpha)](p_T^* - p_N^*)$

where, as before, * denotes foreign country, and α and δ are the shares of tradable goods in the home and foreign countries respectively.

In this case changes in both definitions tend to differ, and can even move in opposite directions, depending on the behaviour of the relative prices in the foreign country (P_T^* / P_N^*).

Finally, from equations (B.14) and (B.13) we can derive a relationship between RER_H and RER_{PPP}:

(B.15) $r_H = r_{PPP} - (1-\beta)\tau + (1-\delta)(p_T^* - p_N^*)$

(which is equation 5)

Again movements in both measures tend to differ, depending on changes in the relative price abroad – as before - and in the terms of trade of the home country.

[38] A case in point can be copper and nitrates in Chile.

ANNEX C: Multilateral Real Exchange Rate Indices

We produced real multilateral or effective exchange rates (REER) for our sample of countries based on at least six main trade partners (US, UK, Germany, France, Japan, and one or two Latin American economies). The multilateral indices were calculated as geometric weighted averages of bilateral real exchange rates, using the following formula (Chinn, 2006):

$$REER_{jt} = \sum_{i=1}^{k} \alpha_{it} RER_{it}$$

where: $REER_{jt}$ is the index of multilateral or effective real rate (in logs) for country j in period t (j = 1 to 6 ; t=1 to 100). α_{it} is the weight corresponding to trade partner i in period t. RER_{it} is the bilateral real exchange rate (in logs) between country j and country i. As before, an increase in the value of the REER index indicates real depreciation, whereas a fall shows a real appreciation of the domestic currency.

Bilateral real rates with countries other than the US are derived as cross rates from the corresponding US dollar series.[39] For example, the bilateral real exchange rate relative to sterling for country j in a given year is obtained as:

$$RER_{uk} = RER_{us}(P_{uk}/P_{us})(1/E_{£/\$})$$

where $E_{£/\$}$ is the nominal exchange rate between the British pound and the US dollar, and P_{uk} and P_{us} are the general price indices of the respective countries.

And the bilateral real series with the US are obtained as:

$$RER_{us} = E_{lc/\$}(P^*/P)$$

Where lc stands for local currency, and as before, P is the internal price index and an asterisk indicates foreign prices. In the case where P^* equals import unit values (PM), the result is the REERpm; and when it equals the CPI of the foreign country the result is REERcpi. REERpm series are derived following a similar procedure as the REERcpi. That is, by treating the PMs as prices for imports from the US valued in dollars.

Note that because import unit values reflect a weighted average of goods priced at different currencies and originated in different countries, the ideal way to construct the multilateral real index is to calculate first multilateral nominal exchange rates (NEER) for each country using trade weights (so that REERpm = NEER*PM/CPI). But this road is a data minefield, because of hyperinflation in some of the trade partners (eg. Germany, Brazil - used as main trade partner for Argentina, Chile and

[39] In this study we use bilateral real rates with the US dollar - using US WPI as the foreign price - available for Argentina (Veganzones & Winograd, 1997), and for Colombia (GRECO, 2002) - using the US CPI. In the case of Chile, there are available multilateral and bilateral series from Díaz et al (2005), though we constructed our own with a wider number of trade partners and annual average series for the CPI – rather than year-end values. For the remaining three countries we constructed both the multilateral and bilateral real exchange rate series. See sources for more details.

Mexico). To get round this problem, the PMs are treated as prices for imports from the US valued in dollars, and then applying cross rates to construct the multilateral index – so that we always work with real exchange rates of third countries.

Nominal exchange rates

The bilateral nominal exchange rate (NER) used to calculate the RER relative to the US refers to the rate applicable to imports. This is consistent with the Harberger concept, which is based on the foreign price of imports, as well as being the more appropriate rate for utility comparison under the PPP concept.

In this way we are capturing some of the distortions associated with exchange rate controls and multiple exchange rates. In general the NER series do not include the effect of parallel rates (legal or illegal), which will be reflected in an alternative series.

In those instances in which there was a unified rate, or a dual regime with an official (usually fixed) rate applied to most current account transactions and a "free" or market determined rate to convert capital transactions, the selection of the appropriate rate has no complications. However, the rate chosen is not always the "official" rate. In some cases, such as Brazil after 1930, the "free" rate ("*tasa livre de cambiu*", which meant more depreciated, not necessarily market determined) was applied to imports, as the objective was to curb its demand in times of foreign exchange scarcity and not primarily driven by ISI considerations (Abreu, 1990).

In the case of multiple exchange rates, when possible, we are working with an average of those rates applied to imports. When the data are available (e.g., Colombia), the average is weighted by the different trade flows associated with each rate. But in the face of data limitations, we are taking simple averages (e.g., Venezuela during 1961-1964 and 1983-1989).

Multiple rates applied to exports are mostly ignored, as we are primarily concerned with imports or importable goods. However, they have been a common feature in some of the LA6 countries. For example, since the early years of the oil exploitation Venezuelan governments have introduced differential rates applicable to oil or other key commodities such as coffee. The rate for oil was set at a lower level than rates applied to other external transactions, as the aim was to increase the amount of dollars that the foreign oil companies had to use to cover their payments in the country. But when the aim was to support domestic coffee producers (e.g., during the Depression years), the rate was raised (Astorga, 2000).

Trade weights

The weights (αs) applied to calculate the effective or multilateral indices are import shares calculated annually (in value terms). We use import shares as weights because it is more consistent with our RER series. In any case, with the exception of Argentina and, to an extent Brazil, where trade and capital flows were characterised by a triangular structure, export shares tend to match those of imports in our sample of countries. We performed a sensitivity analysis for Argentina using weights calculated over all traded goods and the resulting REERcpi series shows no significance changes relative to that calculated with imports shares only.

The coverage over the century ranges from a country average of 75% of all import flows at the start of the century, to 60% towards the end (see Table C1 below). To calculate the weights we re-scaled the original shares so that they add to one. Thus, implicitly, we are distributing pro-rata those import flows that are not accounted for by the main trading partners. We performed a sensitivity analysis by assuming that the real exchange rates between each LA6 country and with the "rest of countries" group were constant - rather than mirroring the patterns of the main trading partners - with no significant changes to the resulting REER series.

Table C1: Import coverage over the century
(in percentages)

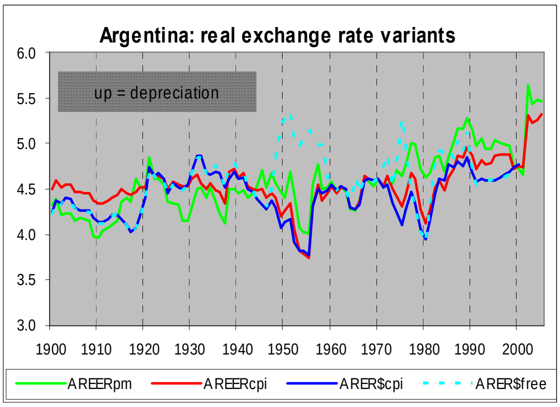
circa	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
1900	75 [12]	75 [12]	77 [10]	90 [32]	71 [56]	88 [30]
1950	54 [24]	80 [45]	72 [46]	81 [68]	93 [83]	83 [69]
2000	58 [19]	56 [23]	57 [22]	58 [34]	85 [74]	64 [41]

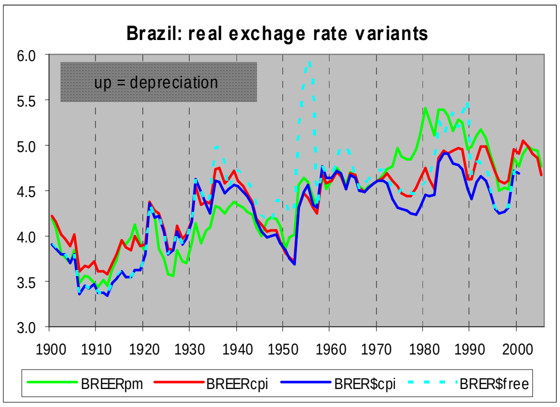
in [ ] percentage of imports from the US

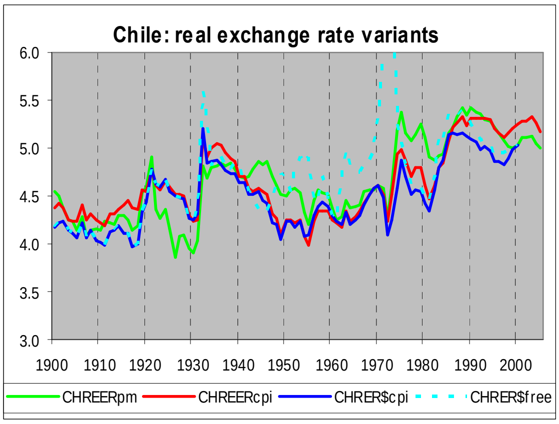
Our sample of trading partners covers at least 70% of imports up to the 1960s, with the exception of Argentina. Over the period 1970-2000, the average share falls to about 60%, reflecting a more diversified trade structure. However, despite the narrowing of the coverage, our multilateral series during the period 1980-2000 behave in line with those constructed by the *Centro de Economía Internacional* (CEI) which encompass a larger number of trading partners (a total of 23, covering 80% or more of trade flows).

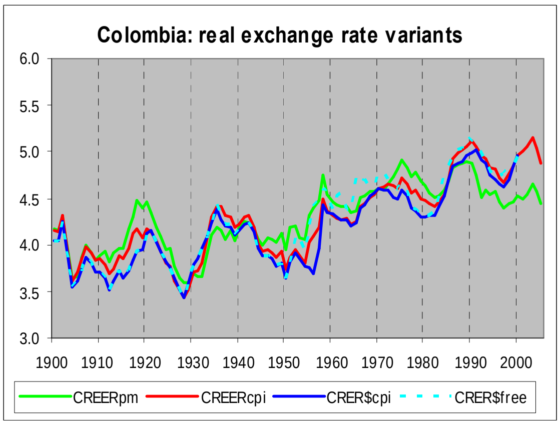
Comparison charts of RER variants by country

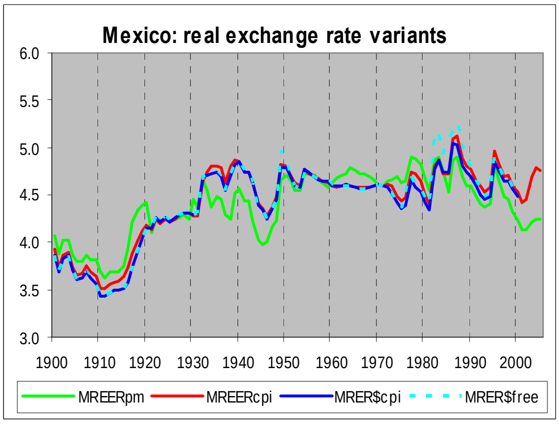
Charts C1

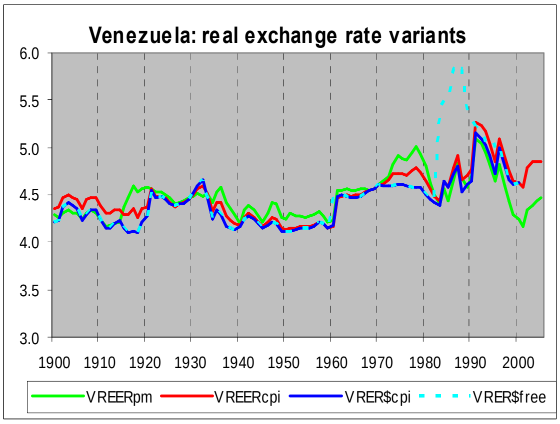












Correlation matrices by country

Table C2: Real Exchange Rate variants, correlation matrix 1900-2000

upper triangle: Argentina; *lower triangle: Brazil*

	REERpm	REERppi	REERcpi	RER$cpi	RER$free
REERpm	1	0.63	0.65	0.51	0.09
REERppi	0.85	1	0.97	0.76	-0.27
REERcpi	0.89	0.92	1	0.84	-0.28
RER$cpi	0.82	0.91	0.95	1	-0.08
RER$free	0.71	0.82	0.73	0.83	1

upper triangle: Chile; *lower triangle: Colombia*

	REERpm	REERppi	REERcpi	RER$cpi	RER$free
REERpm	1	0.85	0.83	0.79	0.51
REERppi	0.90	1	0.99	0.92	0.47
REERcpi	0.90	0.99	1	0.94	0.50
RER$cpi	0.85	0.98	0.98	1	0.56
RER$free	0.87	0.94	0.96	0.96	1

upper triangle: Mexico; *lower triangle: Venezuela*

	REERpm	REERppi	REERcpi	RER$cpi	RER$free
REERpm	1	0.89	0.88	0.88	0.88
REERppi	0.89	1	0.97	0.96	0.95
REERcpi	0.83	0.94	1	0.99	0.99
RER$cpi	0.78	0.86	0.97	1	0.99
RER$free	0.58	0.66	0.76	0.78	1

REERpm: multilateral rate index, using unit value of import indices
REERppi: multilateral rate index, using the US producer price index
REERcpi: multilateral rate index, using the US consumer price index
RER$cpi: bilateral rate index to the US$, using the US consumer price index
RER$free: bilateral rate index to the US$, using market-determined nominal exchange rate

Table C3: Real Exchange Rate variants, correlation matrix 1971-2000

upper triangle: Argentina; *lower triangle: Brazil*

	REERpm	REERppi	REERcpi	RER$cpi	RER$free
REERpm	1	0.82	0.78	0.61	0.03
REERppi	0.85	1	0.99	0.88	0.09
REERcpi	0.50	0.63	1	0.89	0.04
RER$cpi	0.60	0.76	0.85	1	0.22
RER$free	0.71	0.82	0.41	0.71	1

upper triangle: Chile; *lower triangle: Colombia*

	REERpm	REERppi	REERcpi	RER$cpi	RER$free
REERpm	1	0.86	0.80	0.74	-0.50
REERppi	0.36	1	0.99	0.93	-0.24
REERcpi	0.32	1.00	1	0.93	-0.20
RER$cpi	0.17	0.96	0.97	1	-0.17
RER$free	0.21	0.92	0.93	0.97	1

upper triangle: Mexico; *lower triangle: Venezuela*

	REERpm	REERppi	REERcpi	RER$cpi	RER$free
REERpm	1	0.88	0.56	0.53	0.54
REERppi	0.86	1	0.85	0.83	0.83
REERcpi	0.63	0.92	1	0.98	0.89
RER$cpi	0.48	0.85	0.97	1	0.94
RER$free	-0.06	0.14	0.23	0.31	1

REERpm: multilateral rate index, using unit value of import indices
REERppi: multilateral rate index, using the US producer price index
REERcpi: multilateral rate index, using the US consumer price index
RER$cpi: bilateral rate index to the US$, using the US consumer price index
RER$free: bilateral rate index to the US$, using market-determined nominal exchange rate

Intra-LA6 correlation matrices

Table C4: Intra-LA6 correlation matrix for REERpm

upper triangle: 1900-2000; *lower triangle: 1900-1929*

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
Argentina	1	0.71	0.80	0.73	0.54	0.62
Brazil	0.78	1	0.75	0.84	0.74	0.61
Chile	0.58	0.62	1	0.71	0.46	0.58
Colombia	0.64	0.59	0.67	1	0.65	0.62
Mexico	0.66	0.44	0.11	0.34	1	0.51
Venezuela	0.78	0.55	0.23	0.48	0.87	1

upper triangle: 1930-1970; *lower triangle: 1971-2000*

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
Argentina	1	-0.23	0.25	0.19	-0.21	-0.02
Brazil	0.04	1	-0.32	0.75	0.50	0.26
Chile	0.66	0.25	1	-0.06	-0.53	-0.17
Colombia	0.21	0.28	0.37	1	0.45	0.14
Mexico	0.11	0.29	-0.04	0.37	1	0.26
Venezuela	0.10	0.06	0.33	0.40	0.22	1

REERpm: multilateral rate index, using unit value of import indices.

Table C5: Intra-LA6 correlation matrix for REERcpi

upper triangle: 1900-2000; *lower triangle: 1900-1929*

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
Argentina	1	0.36	0.66	0.49	0.17	0.57
Brazil	0.85	1	0.63	0.80	0.76	0.53
Chile	0.74	0.61	1	0.73	0.48	0.68
Colombia	0.15	0.27	0.19	1	0.58	0.68
Mexico	0.72	0.63	0.74	-0.08	1	0.23
Venezuela	0.56	0.42	0.22	-0.04	0.35	1

upper triangle: 1930-1970; *lower triangle: 1971-2000*

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
Argentina	1	0.30	0.54	0.37	-0.11	0.41
Brazil	0.31	1	0.32	0.69	0.22	0.44
Chile	0.69	0.48	1	0.33	0.31	0.22
Colombia	0.74	0.47	0.81	1	0.30	0.33
Mexico	0.56	0.27	0.32	0.30	1	-0.23
Venezuela	0.45	0.24	0.57	0.53	0.04	1

REERcpi: multilateral rate index, using consumer price indices.

Table C6: Intra-LA6 correlation matrix for RER$cpi

upper triangle: 1900-2000; lower triangle: 1900-1929

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
Argentina	1	0.54	0.72	0.51	0.41	0.53
Brazil	0.87	1	0.62	0.72	0.83	0.49
Chile	0.89	0.81	1	0.73	0.59	0.64
Colombia	0.17	0.35	0.25	1	0.58	0.72
Mexico	0.80	0.81	0.82	0.18	1	0.32
Venezuela	0.91	0.75	0.73	0.11	0.68	1

upper triangle: 1930-1970; lower triangle: 1971-2000

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela
Argentina	1	0.43	0.70	0.51	-0.07	0.54
Brazil	0.52	1	0.27	0.66	0.23	0.46
Chile	0.68	0.43	1	0.39	0.22	0.22
Colombia	0.75	0.39	0.78	1	0.15	0.48
Mexico	0.64	0.41	0.44	0.26	1	-0.23
Venezuela	0.32	0.02	0.44	0.60	-0.01	1

RER$cpi: bilateral rate index to the US$, using the US consumer price index.

ANNEX D: Times Series Analysis

Perron's two-stage testing procedure

Consider a trending series generated by $y_t = \mu + \beta t + u_t$, where:
(D.1) $\Delta u_t = C(L)e_t$
with e_t ~ i.i.d. (0, σ_e^2) and C(L) = $\sum_{j=0}^{\infty} c_j L^j$ such that $\sum_{j=0}^{\infty} j\,|c_j| < \infty$ and c_0 = 1.

Making allowances for a one-time change in the trend function, results in two versions of four different structures: 1) a change in level for a non-trending series; and for trending series, 2) a change in level, 3) a change in slope, and 4) a change in both level and slope. For each of the four cases, two versions allow for different transition effects. The first is labelled the "additive outlier model" (AOM) and specifies that the change to the new trend function occurs instantaneously. The second is the "innovational outlier model" where the change to the new trend function is gradual.

The innovational outlier versions have been considered only for Models (A) and (C) (Perron, 1994). The AOM for each of the four specifications for the types of changes occurring at a break date T_1 are specified as follows:

Model (AO-0) $y_t = \mu_1 + (\mu_2 - \mu_1)\ DU_t + u_t$

Model (AO-A) $y_t = \mu_1 + \beta t + (\mu_2 - \mu_1)\ DU_t + u_t$

Model (AO-B) $y_t = \mu_1 + \beta_1 t + (\beta_2 - \beta_1)\ DT_t^* + u_t$

Model (AO-C) $y_t = \mu_1 + \beta_1 t + (\mu_2 - \mu_1)\ DU_t + (\beta_2 - \beta_1)\ DT_t^* + u_t$

where $DU_t = 1$, $DT_t^* = t - T_1$ if $t > T_1$ and 0 otherwise, and u_t is specified by (D.1). Under the null hypothesis $C(1) \neq 0$, while under the alternative hypothesis, $C(1) = 0$.

The test procedures consist of a two-step approach. In the first step, the trend function of the series is estimated and removed from the original series via the following regressions for Model (AO-0) to (AO-C), respectively:

(AO-0) $y_t = \mu + \gamma DU_t + \tilde{y}_t$

(AO-A) $y_t = \mu + \beta t + \gamma DU_t + \tilde{y}_t$

(AO-B) $y_t = \mu + \beta t + \gamma DT_t^* + \tilde{y}_t$

(AO-C) $y_t = \mu + \beta t + \theta DU_t + \gamma DT_t^* + \tilde{y}_t$

where $\tilde{y}_t$ is accordingly defined as the de-trended series. The next step differs according to whether or not the first involves DU_t , the dummy associated with a change in intercept. For Models (AO-0), (AO-A) and (AO-C), the test is based on the value of the t-statistic for testing that $\alpha = 1$ in the following autoregression:[40]

(D.2) $\tilde{y}_t = \alpha\ \tilde{y}_{t-1} + \sum_{j=0}^{k} d_j D(T_1)_{t-j} + \sum_{i=1}^{k} a_i \Delta\tilde{y}_{t-i} + e_t$

[40] There is no need to introduce the dummies in the second step regression for Model (AO-B) where the two segments of the trend are joined at the time of break.

Table D1: Testing for unit roots					
Period 1900-2005 (all series in logs)		Levels and intercept		Level plus trend and intercept	
		ADF	*P-P*	*ADF*	*P-P*
Arg	REERcpi	-0.82	-1.8	-1.49	-2.41
	REERpm	-0.71	-1.69	-2.92	-4.19***
Bra	REERcpi	-1.69	-1.86	-3.25*	-3.81**
	REERpm	-1.4	-1.38	-2.75	-3.74**
Chi	REERcpi	-1.33	-1.56	-1.99	-2.42
	REERpm	-1.79	-1.92	-3.13	-3.51**
Col	REERcpi	-1.72	-1.37	-3.49**	-3.40*
	REERpm	-2.27	-1.9	-2.91	-3.11
Mex	REERcpi	-1.93	-1.65	-2.14	-2.35
	REERpm	-2.1	-2.1	-1.87	-2.65
Ven	REERcpi	-1.06	-1.63	-2.07	-2.52
	REERpm	-2.49	-2.63*	-2.82	-2.89

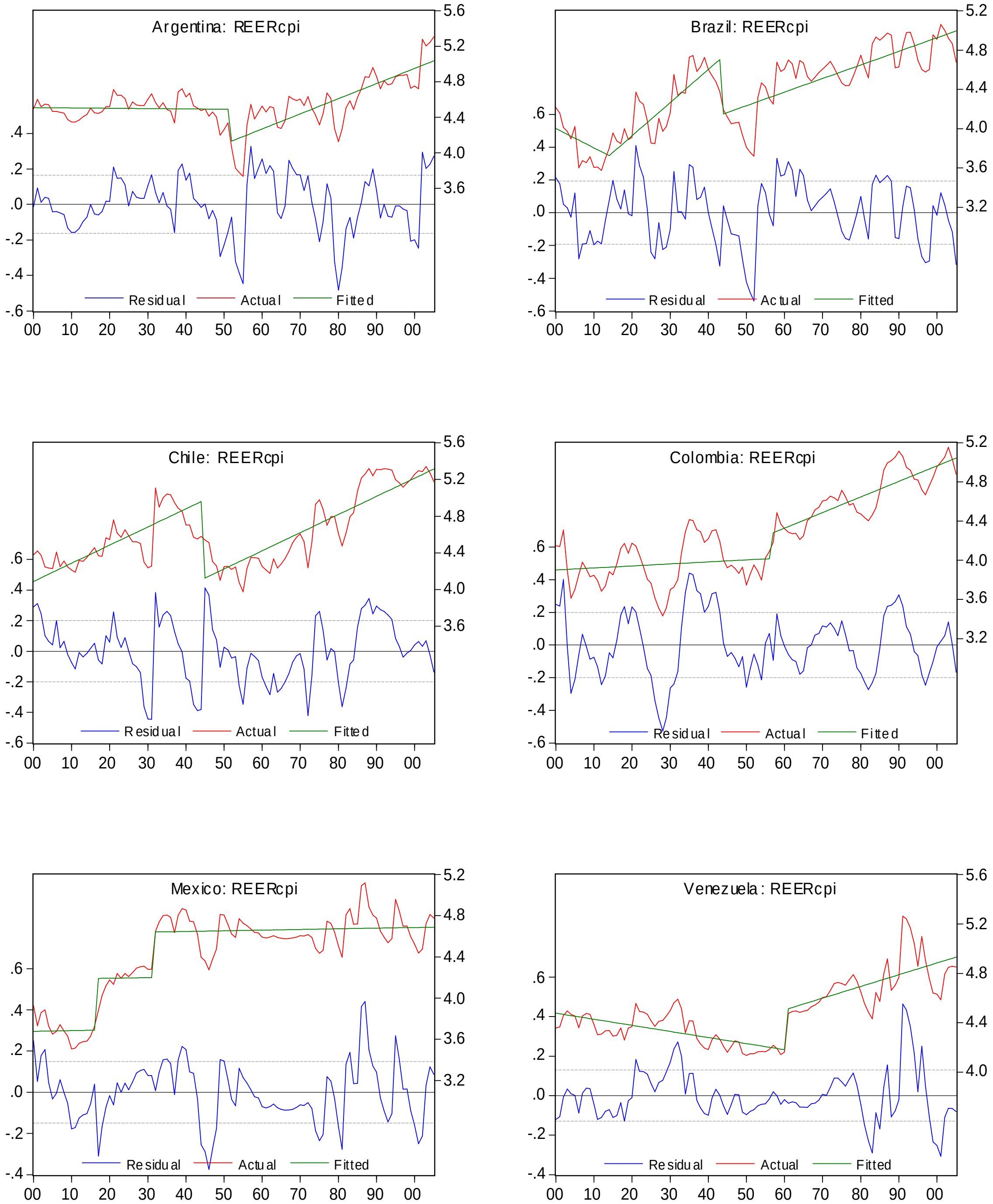
ADF: Augmented Dickey-Fuller test; P-P: Phillips-Perron test.
Critical values for series in levels: -3.50 (at 1% of sig.); -2.89 (5%); -2.58 (10%);
and with trend & intercept: -4.05 (1%); -3.45 (5%); -3.13 (10%).
(*), (**), & (***) indicate that the unit-root hypothesis is rejected at the 10%, 5%, and 1% level of significance, respectively. Truncation lag = 4 in all cases.

Table D2: Perron stationarity test fot REERpm											
period 1900-2005			**First stage**							**Second stage**	
	(1) *model*	(2) *Tb*	(3) $\hat{\beta}$	(4a) $\hat{\theta}_1$	(4b) $\hat{\theta}_2$	(5a) $\hat{\gamma}_1$	(5b) $\hat{\gamma}_2$	(6) *SE*		(7) $\hat{\alpha}$	(8) $t_{\hat{\alpha}}$ (ADF)
ARG	AO-B	1953	**0.003**			**0.012**		*0.200*			
	AO-C	1953	**0.007**	**-0.287**		**0.012**		*0.188*		**0.43**	-4.26***
	AO-A	1985	**0.006**	**0.321**				*0.199*			
	AO-C	1976	**0.004**	**0.198**		**0.011**		*0.195*			
BRA	AO-C	1980	**0.016**	**0.493**		**-0.042**		*0.208*		**0.54**	-4.72***
	AO-B	1992	**0.017**			**-0.050**		*0.231*			
	AO-C&C	1914&1980	**-0.046**	**0.424**	**0.466**	**0.063**	**-0.042**	*0.187*		**0.54**	-4.22***
CHI	AO-A	1974	**0.004**	**0.511**				*0.224*		**0.72**	-3.95***
	AO-B	1974	**0.008**			**0.009**		*0.261*			
	AO-C	1974	**0.004**	**0.584**		-0.006		0.223			
COL	AO-A	1956	0.002	**0.460**				*0.191*		**0.68**	-3.78***
	AO-B	1955	**0.008**			0.000		*0.224*			
	AO-C	1956	0.003	**0.463**		-0.001		*0.192*			
MEX	AO-C	1917	-0.017	**0.704**		0.020		*0.208*			
	AO-B	1989	**0.011**			**-0.060**		*0.190*			
	AO-0&0	1917&1989	**0.008**	**0.363**	**-0.467**			*0.171*			
	AO-C&B	1917&1989	**-0.017**	**0.582**		**0.025**	**-0.05005**	*0.154*		**0.46**	-4.2***
VEN	AO-A	1961	-0.001	**0.358**				*0.164*		**0.75**	-3.82***
	AO-B	1961	**0.003**			0.002		*0.188*			
	AO-C	1972	0.002	**0.427**		**-0.014**		*0.157*		**0.68**	-4.08***

Columns 3-5: estimates in **bold** are significant at least at the 5% level.
SE: standard error of the regression.
(*), (**), and (***) indicate that the critical value is rejected at the 10%, 5%, and 1% levels, respectively.

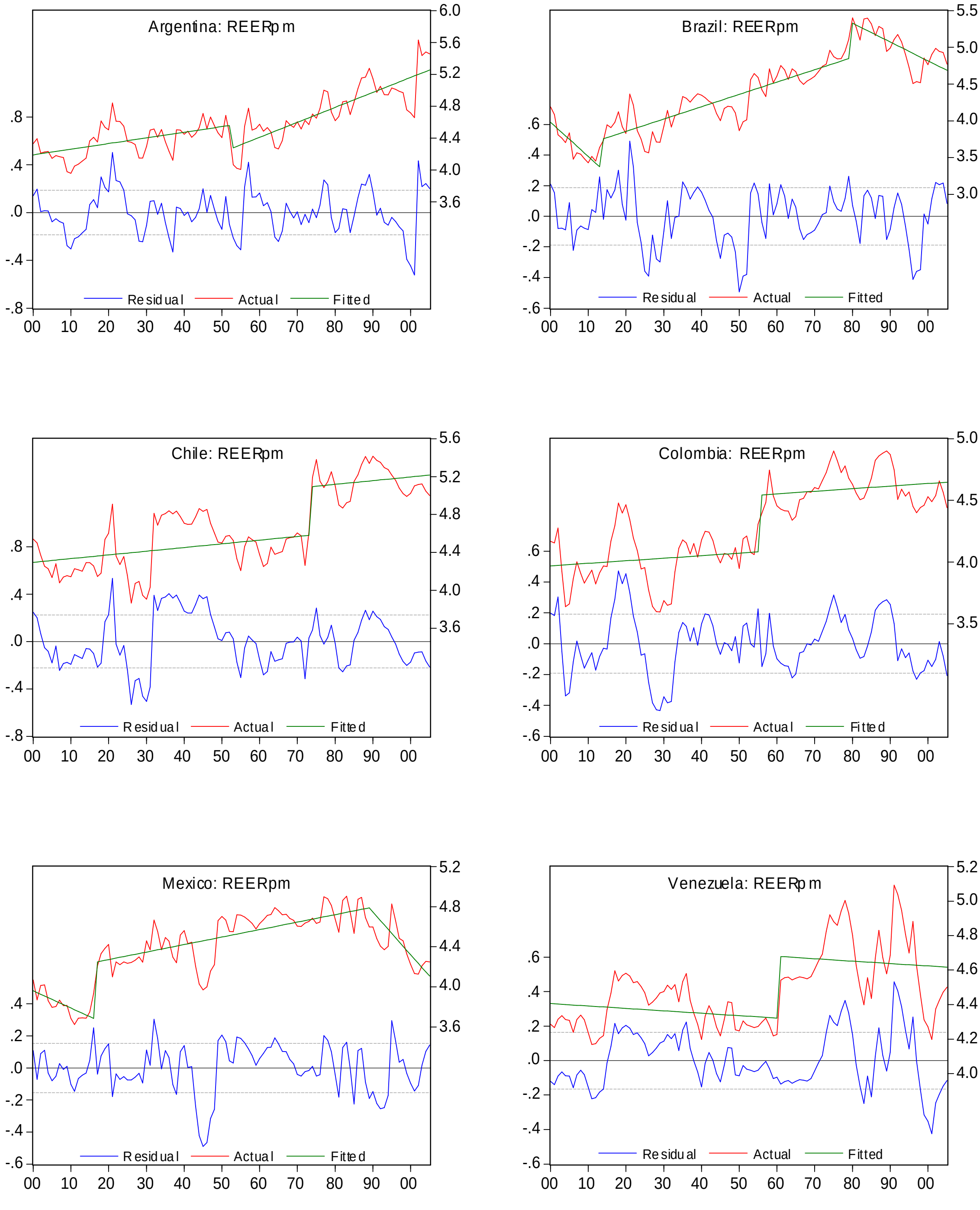
Additive models for REERcpi series

Charts D1



Additive models for REERpm series

Charts D2



ANNEX E: Data Sources and Assumptions

Real Bilateral Exchange Rates

Argentina
1900-1992: uses OECD dataset which originates in Veganzones & Winograd (1997). The series used in our work correspond to what the authors labelled "real exchange rate imports" and "real exchange rate parallel" (other options are: "RER exports", and "RER commercial"). The RER imports series is calculated relative to the US as RERus = Epeso/US$(WPIus/CPI). In order to obtain our ARER$cpi series, we multiply the original OECD series by the ratio CPIus/WPIus. We apply a similar adjustment to the original RER parallel to obtain our ARER$free series.

1993-2005: we complete forward the OECD series using growth rates of RER indices calculated from nominal exchange rate and price data (see below).

Chile
Own calculations, mostly based on information provided in the Díaz, Lüders, and Wagner database (see Díaz et al, 2003). They constructed a long-term RER series over the period 1810-2000, including US and UK as main trade partners. Our real bilateral exchange rate for Chile (CHRER$) differs from theirs in that we use average annual inflation rather than year-end inflation, and that our multilateral rate (CHREERcpi) comprises seven trading partners.

Colombia
1900-1905 and 2000-2005: own estimates based on nominal exchange rate and price data (see below). Otherwise, GRECO's real exchange rate series without tariff ("tipo de cambio efectivo real sin arancel").

Mexico
Own estimates based on nominal exchange rate and price data. We assume the rate of inflation matches currency depreciation during the period 1912-1916. The country adopted the gold standard again in 1917 and the exchange rate was set at its 1911-12 parity, with prices and wages adjusted accordingly (Cárdenas & Mann, 1987).

For *Brazil* and *Venezuela* we construct the series based on nominal exchange rate and price data (see below).

Nominal Exchange Rate (local currency per US dollar)

Argentina
Uses OxLAD for the official exchange rate. Note that in the case of Argentina we are relying on Veganzones & Winograd (1997) for estimates of the real exchange rates.

Brazil
1900-1933 and 1938 from IBGE (based on Abreu, 1990). During these years there was a unified exchange rate. In 1933 a multiple rate regime was implemented. In1934 we use the controlled exchange rate, between 1935 and 1937 and 1939-1946, the "taxas de câmbio livre" which was applied to imports. For the period 1947-2000

we employ IPEA's commercial exchange rates ("taxas de câmbio commercial"). They correspond to annual average of the selling rate. The commercial exchange rate was one of several rates in place until June 1994. After that date the system was simplified with a commercial rate and a fluctuating rate (market determined). For more details, see Abreu (1990) and explanatory notes in IBGE (2003).

In October 1953 a multiple exchange rate regime was introduced ("Instrução 70 da SUMOC"), with five rates applicable to import transactions. Imports were allocated according to a system of auctions ("leilões de câmbio"). In 1957 the system was simplified, reducing the number of import categories from five to three. We were not able to clarify the methodology used by IPEA to produce their commercial exchange rate series during the periods 1953-1957 and 1957-1961. An ideal procedure – as suggested by Marcelo Abreu - would look at the "relatorios" of SUMOC for information about the different rates applied to different import groups. But this is beyond the scope of the present work.

Chile

Uses series in Díaz et al (2003), except in 1932-33, where we use average exchange rate values estimated in Lüders (1968). During the period 1900-1930 the nominal exchange rate corresponds to the official rate and during 1960-2000 to annual averages of the exchange rate applied to banking transactions ("tipo de cambio del mercado bancario"). For the remaining years, when there were differentiated rates in place, the exchange rates chosen reflect those applied to import transactions. See the methodological notes in Díaz et al (2003, chapter 4, pp.190-194) for further details.

Colombia

During the period 1900-1904 the exchange rate peso/US$ is calculated based on the devaluation of the peso relative to sterling (López Mejía, 1990). From 1905 to 1930, we use GRECO (2002). During the period 1931-1974 we use a weighted average of the nominal exchange rate applied to imports transactions from Romero (2005). The series is completed forward using the rate of growth of GRECO's series. The latter mostly reflects rates applied to transactions in the trade account. Special rates applied to some transactions in the capital account, and to oil revenues in periods under exchange controls are not taken into account (this information was provided by Carlos Esteban Posada of GRECO).

Mexico

Uses OxLAD for 1900 to 1980, except during 1915-1917 when estimates came from Cardenas & Manns (1987). After 1981 figures are from Banco de México - available in ITAM (2004).

Venezuela

Uses Izard (1970) during period 1900-1937 and BCV (2000) thereafter. During the three episodes with differentiated rates for imports (1960-1964; 1983-1989; and 1994-1995) we take the simple averages of the range of rates applied to imports (we believe that the resulting averages should not be too far away from the properly weighted series).

With the exception of Argentina, the parallel or market-determined exchange rate during the period circa 1950 to 1999 comes from Reinhart and Rogoff (2004). When applicable, the sources for the first half of the century are: Brazil, "taxa de câmbio livre" from Abreu (1990); Chile, market rate from Díaz et al (2003); Colombia, exchange rate applicable to short-term capital flows from Romero (2005); and Mexico, market rate from ITAM (2004).

Consumer Price Indices (CPI) and CPI inflation (annual averages)

Argentina
1900-1980: sources as in OxLAD. 1980 onwards: CEI.

Brazil
In the case of Brazil there are several options for price indices over the period. For the sake of inter-temporal consistency we decided to use the implicit GDP deflator estimated by IBGE as our measure for the country's internal price index. The same choice was made by Fiorencio & Moreira (1997) in their study of the real exchange are during the period 1947-1995.

However, sensitivity analysis performed with alternative price series does not change significantly the long-run behaviour of the real exchange rate series up to the mid-1980s. For example, one option we tried uses the following sources:
1900-1913: Catão (1992) wholesale price index; 1914-1944: GDP deflator from IBGE (1990); 1944-1980: *indice geral de preços - disponibilidade interna* (IGP-DI). Fundação Getúlio Vargas; 1981-2005: IMF-IFS.

During the hyperinflation years of the late 1980s and mid 1990s, we noticed that the use of the "IPC ampliado" (IBGE) results in a discontinuity circa 1989. This problem is not present in the CPI series published by the IMF or in the GDP implicit deflator.

Chile
1900-1927: Mamalakis (1983). Figures taken from OxLAD.
1928-2000: Chile's *Instituto Nacional de Estadísticas* (INE). During the 1970-1977 period the original INE series was corrected using the information provided by Cortazar & Marshall (1980).
1971-1972: The rate of inflation in 1971 was calculated by applying the same adjustment used by Díaz at al (2003) in the estimation of the December-December series. For 1972 we assume a correction factor that reflects the lower acceleration in annual inflation relative to the year-end values.

Colombia
Uses GRECO after 1905. During the period 1900-1905, inflation estimates are from López Mejía (1990).

Mexico
1900-1913: wholesale price index in Mexico City from ITAM (2004).
During 1915-1917 inflation grows in line with currency devaluation (from Cardenas & Manns, 1987).1918 onwards: uses OxLAD.

Venezuela
1900-1944: general price index from Baptista (1997). After1945: CPI from BCV.

Series of unit value of imports

Argentina: Figures for 1900-1986 are from OxLAD. Then the series in completed to 2005 using the rate of growth of the import unit values index published by the country's Economy Ministry (MECON).

Brazil: 1901-2000: IBGE (2003). Value for 1900 is estimated using the rate of growth of the US producer price index. The series is completed to 2005 using rate of growth on unit import values published by ECLAC SYLA.

Chile: Díaz et al (2003). Completed to 2005 using rate of growth on unit import values published by ECLAC.

Colombia: Sources as in OxLAD, completed to 2005 using ECLAC SYLA.

Mexico: 1900-1927: index grows in line with the US producer price index. 1928-1972: CEPAL (1976). ECLAC SYLA thereafter.

Venezuela: OxLAD for 1900-1983. Own calculations based on BCV data of unit import volumes and import dollar values for 1984-2000. ELAC SYLA thereafter.

Trade weights

Import weights by country of origin are calculated from annual import values from the following sources:

Argentina

Mitchell (1993) for period 1900-1951; IMF Historical Trade Statistics (HTS) for 1952-1980; and CEI for 1990-2000. Figures for 1980-1990 are interpolated. Figures of import from Japan for the years 1929, 1932, 1936 and 1937 come from US Tariff Commission (1942). The countries included are: France, Germany, Japan, UK, US, and Brazil.

Brazil

IBGE (2003), except 1938-1947 from Mitchell (1993). The countries included are: France, Germany, Japan, UK, US, and Argentina.

Chile

Mitchell (1993) for period 1900-1951 and IMF HTS for 1952-1980; with the exception of US and UK which weights during 1900-1960 are taken directly from Díaz et al (2003). After 1990 data comes from ECLAC and Chile's *Servicio Nacional de Aduanas*. Figures for 1980-1990 are interpolated. Import shares from Brazil prior to 1950 are assumed to be zero. The countries included are: France, Germany, Japan, UK, US, Argentina, and Brazil.

Colombia

Mitchell (1993) for period 1900-1951 and 1988; IMF HTS for 1952-1980; and DANE for 1994-2000. Figures for 1980-1987 and 1989-1993 are interpolated. Import shares from Venezuela prior to 1926 are assumed to be 0.6% (1926-28 average) and from

Brazil prior to 1941 to be 0.1%. The countries included are: France, Germany, Japan, UK, US, Venezuela, and Brazil.

Mexico
Mitchell (1993) for period 1900-1947; IMF HTS for 1948-1980; and INEGI thereafter. Figures during 1914-1919 are interpolated. Import values from the US and the rest of Latin America during 1900-1911 and 1932-1979 from ITAM (2004).

Venezuela
Mitchell (1993) for period 1900-1947 and 1988; IMF HTS for 1948-1980. Weights for US, UK, and Germany during 1920-1929 which are taken directly from Machado & Padron, (1987, Table IX, p.82). After 1993 data comes from ECLAC and CEI. Figures for 1980-1987 and 1989-1993 are interpolated. Import shares from Colombia and Brazil prior to 1948 are assumed to be 0.4% (1948 value) and Brazil prior to 1948 to be 0.1%, respectively. The countries included are: France, Germany, Japan, UK, US, Colombia, and Brazil.

With the exception of Brazil and Argentina after 1929, import data between the LA6 and Japan start circa 1950. In such cases we assume that import flows from Japan during the first half of the century were insignificant.

RER-related data on third countries

France: The CPI during the period 1900-1989 is sourced from Maddison (1991), and IMF-IFS thereafter. We use Officer (2002) for the nominal exchange rate to the US$.

Germany: The CPI during the period 1900-1959 is sourced from Mitchell (1993), and IMF-IFS thereafter. We use Officer (2002) for the nominal exchange rate to the US$.

Japan: The CPI during the period 1900-1960 is sourced from Maddison (1991), and IMF-IFS thereafter. We use Officer (2002) for the nominal exchange rate to the US$ after 1916.

Norway: Data from both the CPI and the nominal exchange rate come from Statistics Norway, Historical Statistics.

Spain: The real exchange rate index comes from Aixala (1999).

UK: Index of producer prices 1900-1970 is from Mitchell (1993), and IMF thereafter. CPI (retail price index) is from McCuster (2001). We use Officer (2001) for the exchange rate US dollar per British pound.

US: Index of producer prices for 1900-1912 is from the USDC (1975); for 1913-2000 we use the BLS (2002). CPI for 1900-1970 is from Michell (1993), and IMF thereafter. We use Officer (2001) for the nominal exchange rate to the British pound.

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(Data sources are in a separate section at the end)

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