DOLLARIZATION AND PRICE DYNAMICS

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To my mother Ernestina and my father Vicente

and

To my wife María Agustina

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CHAPTER I

INTRODUCTION

Dollarization has recently become an exchange rate regime option for emerging market economies. However, despite recent experiences with dollarization, not much is known about its short-run effects. Similarly, although dollarization is thought of as irreversible, not much is known about the long-run consequences of the regime. The empirical literature on dollarization is scarce mainly because there are not many dollarized countries in the world. This study contributes to the scarce empirical literature on dollarization by investigating the short and long-run effects of dollarization on the dynamics of prices at the macro and the micro level. Specifically, this study addresses questions about the stabilizing and integrating effects of dollarization on prices in the short and the long run, and the consequences of dollarization on the price level and its relationship with per-capita income in the long run. This study also presents a comprehensive survey of the relevant literature on dollarization. The conclusions of this survey and the results of the analyses presented in this study have clear policy implications for the government of a country considering the adoption of an exchange rate regime such as dollarization.

Dollarization is recommended for countries with particular characteristics, which would make the benefits of dollarizing much larger than the costs. For these countries other exchange rate regimes would introduce unwanted volatility and make their currencies vulnerable to speculative attacks. Alternatively, dollarization should bring

stability, credibility and discipline to these economies, and the possibility of further integration to a stable and more developed economy. Under this positive environment, the governments of dollarized countries are expected to focus their efforts on modernizing and taking the appropriate actions to promote economic growth.

In this study, the short-run stabilizing effects of a credible system like dollarization are examined in the context of Ecuador, a country that dollarized in January 2000. Exogenous shocks to the Ecuadorian economy in 1998 triggered a severe financial and currency crisis which fully developed during 1999. As a consequence, commodity prices fell substantially below U.S. levels in dollar terms and, apparently, the fall would have continued had it not been for dollarization.

Using monthly data for the period from January 1995 to April 2003, this study shows how the adoption of dollarization put an end to the Ecuadorian 1999 currency crises, and allowed prices in Ecuador relative to the U.S. to return to pre-crisis levels, not only at the aggregate but also at the commodity level. This study finds that micro-prices are stationary as a panel with half-lives of about twelve months – results that are consistent with relative Purchasing Power Parity and the Law of One Price. When the analysis uses structural breaks to control for the large price deviation that took place due to the crisis, the stationarity results become stronger, and the estimated half-life for the average commodity becomes no greater than two months. These estimates are significantly smaller than the literature consensus of three to five years for cross-country analyses.

This study also presents evidence of a possible short-run integrating effect of dollarization within Ecuador. The study shows that after the start of dollarization, 11 Ecuadorian cities became more integrated with the capital city, Quito, in terms of price

levels. That is, the price level gaps between the other cities and Quito narrowed with dollarization. This result, however, does not imply an overall price integration of the cities with one another, indicating that there are probably other factors, in addition to dollarization, that affect the within-Ecuador price dynamics and that need to be investigated further.

A stronger result in this study is about a short-run effect of dollarization on relative price volatility. As expected with dollarization, the volatility of the real exchange rate between Ecuador and the U.S. declines because nominal exchange rate volatility is eliminated. This study shows that dollarization in Ecuador has also been accompanied by a decline in domestic price volatility that causes the volatility of the real exchange rate to be even lower. Interestingly, the volatility of the relative prices of the other Ecuadorian cities with respect to Quito has also declined with dollarization even though there is no currency exchange between the cities. It seems that dollarization has produced a "narrowing of the border" between Ecuador and the U.S., and between Quito and the other Ecuadorian cities.

This study also presents an analysis of long-run price level convergence under dollarization and other alternative exchange rate regimes. The analysis focuses on Panama, a country that has been dollarized since 1904. According to the literature, after such a long time, there should be high price integration between Panama and the U.S., the anchor country. This would be particularly true considering that the consensus in the literature is that Purchasing Power Parity holds in the long run. In addition, the fact that Panama has achieved trade and financial integration with the U.S. and the international markets may have contributed to not only price level but also income level integration.

The results of a long-run comparative analysis of dollarized Panama and 12 non-dollarized Latin American countries using annual data for the period 1950-2000 indicate that Panama is different in that the volatility of its relative price with respect to the U.S. is outstandingly low. This is the result of an inflation rate that is generally lower than that of the U.S. and of unusually stable prices. Clearly, dollarization has a stabilizing effect on prices not only in the short run but also in the long run. However, dollarization has not contributed to rapid economic growth in Panama. In terms of the mean growth rate of real per-capita GDP for the period of analysis, Panama's performance is roughly the same as that of the "average," i.e. typical, Latin American country.

In addition to economic growth performance, there are other aspects in which Panama is similar to the average non-dollarized Latin American country during the period 1950-2000. For both Panama and the average non-dollarized Latin American country, the CPI-based real exchange rate shows an overall tendency to depreciate over time – a result that violates long-run Purchasing Power Parity. This result occurs despite a wide heterogeneity across the Latin American countries in terms of openness, intensity of trade with the U.S., rate of inflation, and the exchange rate regime. The findings of an analysis using price levels suggest that the depreciating real exchange rate is an indication that the price levels of both Panama and the average non-dollarized Latin American country are diverging from the U.S. level. If anything, the relative price levels of the countries with respect to the U.S. seem to be converging to a positive relationship with their relative income levels as predicted by the Balassa-Samuelson hypothesis. According to this result, Panama's price level is explained by its per-capita income, and

no extra effect can be attributed to dollarization. A question that remains open is whether dollarization may have affected the level of Panama's income itself in earlier periods.

The overall implications of this study are the following. The clearest effect of dollarization in both the short and the long run is that of a price stabilizer. In the long run, dollarization probably contributes to trade and financial integration with the U.S. However, it does not produce price level convergence of a dollarized country to the U.S., unless the dollarized country manages to generate income growth. Dollarization may contribute to the economic growth of a country but only indirectly by providing a stable economic environment. Under dollarization, as under any other exchange rate regime, it is the government's actions that have a more direct effect on economic performance. If economic reforms are needed before dollarization, they will still be needed after dollarization. Governments should promote productivity growth as the underlying force that could drive not only price level convergence but also income convergence to the anchor country.

CHAPTER II

DOLLARIZATION: A SURVEY

1. Introduction

Dollarization, in its general definition, occurs when a country adopts a stronger, more stable currency, generally that of a more advanced country, as its own. The advanced country is called the "anchor" country. Under dollarization, the foreign currency becomes the only, or the main, legal tender in the country. When the domestic currency is maintained, its role is secondary, and its issuing must be fully backed by reserves of the foreign currency. When a country dollarizes, it gives up its ability to devalue and its control on monetary policy. Because its Central Bank cannot print money, the country loses seigniorage revenue, and the ability of financing through this activity. Without the option of printing money, the Central Bank cannot play the traditional role of lender of last resort to domestic banks in trouble.

The main motivation for studying dollarization and its ramifications is the increased interest in the topic among developing countries, especially of Latin America since 1999 when Argentina's President Carlos Menem proposed to eliminate the country's peso and replace it with the U.S. dollar. Dollarization was presented as the solution to the country's problems after dipping into a serious recession under a convertibility system. Without a consensus about the implied benefits and costs, the plan could not materialize. However, dollarization was adopted in another South American country, Ecuador, in January 2000, and in El Salvador one year later. With this move, Ecuador became the

largest sovereign country in the world using the dollar as its money, a title that had been held by Panama for about 100 years. The move, however, is a risky one because the consequences of dollarizing are still unclear.

"What started as an intellectual, but mostly impractical idea, has recently become a real policy option" (Edwards, 2001, p. 249.) After unsuccessful experiences, with different exchange rate regimes, from fixed, through intermediate, to free floating, some countries may find in dollarization a way to import needed stability from an advanced country. Stability and the credibility of sound money may set up the right conditions for the integration to international markets which would foster financial development and economic growth.

Dollarization has its supporters and detractors, but the truth is that being a relatively new topic of interest, the literature about it is scarce, particularly the empirical literature. This chapter provides a review of the relevant available literature on dollarization, and it is organized as follows: Section 2 provides a review on the motivations for a country to dollarize. Certain countries may be more compatible with a dollarized system than others, but that does not prevent any country from dollarizing unilaterally. Section 3 provides a review on recent empirical developments. Most of these studies investigated the costs and benefits of dollarization in the context of the Mexican economy, but they are still relevant to any country considering adopting the dollar as their currency. Section 4 provides an assessment of short and long-run economic consequences. For certain countries, the potential benefits of dollarization would outweigh the costs, but dollarization is not a guarantee for economic success. Under dollarization, a government must still do the right actions that promote economic growth. Section 5 concludes.

2. Reasons for a Country to Dollarize

2.1. Optimum Currency Areas and Modern Criteria

Frankel (2001) considers two sets of criteria relevant to a country's decision to dollarize. The first has to do with the traditional Optimum Currency Area (OCA) criteria.[1] According to the OCA literature, there are certain structural characteristics that would make it beneficial for a country to dollarize. These characteristics are small size, openness to trade (especially with the anchor country), high labor mobility between the country and the anchor country, symmetry of shocks or business cycles with those of the anchor country, and the availability of a fiscal mechanism to cushion downturns. According to Frankel (1999a), by "fixing firmly" its exchange rate with the anchor country, a country that meets these criteria would be largely benefited from exchange rate stability, and would be "less likely to need monetary independence in the first place."

The traditional OCA criteria evolved from the pioneer work of Mundell (1961). Mundell's focus was on the role of factor mobility to counteract the effects of asymmetric shocks and sticky prices. If one region is experiencing a recession and another a boom, factors could move from the former to the latter for the benefit of the two regions. According to Mundell, if factors can freely move between two nations, flexible exchange rates are not needed as a stabilizing tool. In a later study, McKinnon (1963) introduced small size and openness as features that would facilitate the integration of a country to a currency area. McKinnon suggested that a small country's currency could provide more

[1] An optimum currency area is defined by Frankel (1999b, p. 11) as "a region for which it is optimal to have a single currency and a single monetary policy." By dollarizing, a country explicitly adopts the same currency as, say, the U.S., and implicitly adopts the U.S. monetary policy. The question is whether the move is optimal or not.

utility under a fixed exchange rate system with the currency of a larger, more developed country. For highly open countries flexible exchange rates would be destabilizing. More recently, Eichengreen's (1994) study indicates that if a country's trade is concentrated with a particular partner, the means-of-payment and unit-of-account functions of money can be better serviced by having a common currency with that partner. Kenen (1969) suggests that, once a common-currency is adopted, the survival of the system would be facilitated if the countries have or get to achieve a high degree of diversification in production. Diversification can provide further protection against shocks. The effect of shocks on some sectors of the economy can be compensated by production in the unaffected sectors.

The second set of criteria considered by Frankel (2001) is based on recent developments. Contrary to the traditional OCA criteria, which concentrate on the structural characteristics of countries, these "modern criteria" arise from the desire of certain countries to import economic stability and credibility. First, a country can use dollarization as a way to inherit monetary stability after a history of high inflation or devaluations that has led citizens to distrust the government institutions. Second, a country may want to attract new investment and have better access to foreign credit, after achieving monetary stability and credibility through dollarization. Third, a country may want to become more integrated with an advanced country not only financially, but also politically, to reap the benefits of this integration, among them to foster economic growth. And fourth, a country may find it natural to formally dollarize if its economy is already dollarized informally, with citizens having lost confidence in the domestic currency.

Alesina and Barro (2000) investigate the determinants of optimum currency areas both theoretically and empirically, focusing on the effect of a common currency on reducing the transaction costs of trade. Their conclusion is that the smaller the countries and the larger the number of transactions in the world, the smaller the number of currencies that will be needed in the future. Alesina and Barro (2001) indicate that some countries could only justify their domestic currencies on grounds of national pride, because otherwise they would be better off adopting a stronger currency. A country in this situation has authorities that lack policy commitment, which is reflected by high and volatile inflation. The argument is stronger if the country trades a lot with the anchor country, if their business cycles are highly correlated, and if the bilateral relative price level (i.e. the real exchange rate) is roughly stable. Alesina and Barro's (2001) argument presents a combination of the traditional and modern criteria, mentioned above, for the adoption of a common currency, and add a new criterion, the one about a stable relative price. This criterion, just as the traditional criteria, implies a certain degree of integration between the adopting and the anchor countries already in place.

Although it would be ideal for a country to satisfy all the traditional OCA criteria before joining a currency area, i.e. before dollarizing, that is not always possible. At best, only some of the criteria will be met. Niskanen (2000) mentions that the countries in the Western hemisphere are very heterogeneous, facing asymmetric shocks and lacking labor mobility, particularly with the U.S. According to Niskanen, this should be sufficient reason for Latin American countries to consider dollarization only if nothing else works. And, even if the decision is made in favor of dollarization, Niskanen considers that the transition to the new system should be gradual and never rushed. For example, his

opinion is that a country like Ecuador should have considered implementing a currency board before dollarizing in 2000.

Some countries may make their decision to dollarize mainly on grounds of the traditional OCA criteria, while others may fit the modern criteria better. According to Frankel (2001), most Central American countries fit the traditional criteria "fairly well." For example, in 2001, El Salvador dollarized after a careful analysis of its current situation. Its economy was already highly dollarized informally, and most of its trade was with the U.S. In addition, the country was receiving an important volume of remittances from a large population of Salvadorans residing in the U.S. The benefits of dollarizing more than compensated the cost of losing the ability to run an independent monetary policy.[2] Unlike El Salvador, in the year 2000 Ecuador dollarized out of desperation amid a severe economic crisis. The country needed to import stability and curb inflation, and dollarization was deemed the only choice. Although the country met some of the traditional OCA criteria (being a small, open country that traded mainly with the U.S.), its decision was mainly based on the modern criteria.

Some authors suggest that, even if the traditional OCA criteria are not satisfied beforehand, they may be satisfied after a country dollarizes or joins a currency area, at least to some degree. McKinnon (1963) indicates that any lack of factor mobility – a crucial requirement according to Mundell (1961) – may be compensated by the implementation of appropriate economic policy. For example, countries can promote diversification in production, or can use fiscal policy as a substitute for some monetary

[2] El Salvador did not explicitly replace its domestic currency, the "colón," with the U.S. dollar. The Salvadoran Monetary Integration Law allows the concurrent circulation of both the colón and the dollar. However, the same law abolished the power of the Central Bank to issue new domestic currency. In practice, the implementation of the law has produced a *de facto* dollarization in the country. People do not want the domestic currency anymore, and only dollar bills and coins circulate.

policy aspects. This, however, could prove to be a difficult task. Frankel and Rose (1998) point to other channels. They indicate that even if countries start with relatively low factor mobility, their integration in a currency area may eventually foster mobility. Using thirty years of data for twenty industrialized countries, they conclude that international trade patterns and business cycle symmetry are "endogenous," in the sense that countries that take steps toward economic integration become more likely to satisfy the OCA criteria over time. Once countries become part of a currency area, trade and factor mobility are encouraged. In addition, the greater trade integration is, the fewer the incentives for factor mobility. Frankel (1999b) finds that trade integration is positively correlated with income for the members of a currency area. Rose and van Wincoop (2001) add that the use of a common currency leads to substantial increases in welfare as measured by a consumption index.

Some authors do not agree with the hypothesis that joining a currency union will foster more integration in the future. Eichengreen (1992), Krugman (1993), and Bayoumi and Eichengreen (1994) state that as countries trade more, instead of becoming more diversified in production as required by Kenen (1969), they would tend to become more specialized in the sectors in which they have comparative advantage. This would work against the survival of the currency area. Under specialized production, asymmetric or sector-specific shocks would affect some members more than others, and the shocks could not be counteracted if there is no independent monetary policy available. However, this seems to be only a theoretical possibility. In an empirical study, Frankel and Rose (1998), show that more trade between countries is, in fact, associated with more

synchronized business cycles, making individual monetary policies less necessary for the countries.

2.2. Economic Vulnerability

Willett (2003), in an analysis of the OCA criteria, concludes that there is simply not one exchange regime that is best for every country.[3] Nevertheless, the author points out that for a small and highly open economy, the domain of its currency may not be large enough for it to be viable. Specifically, Willett mentions three main factors that undermine the viability of a domestic currency: 1) high trade ratios, 2) high and variable inflation, and 3) high degree of dollarization or currency substitution of any kind.

A highly open economy is extremely vulnerable to changes in the nominal exchange rate, because exchange rate volatility is quickly translated into price volatility. Namely, exchange rate depreciation is quickly translated into domestic inflation. This is particularly true if, because of openness, most of the commodities that are consumed domestically are traded rather than non-traded. In some developing countries, particularly those of Latin America, continuous devaluation and high inflation have caused the domestic currency to lose its store-of-value function. As a consequence, citizens have looked for assets denominated in a foreign, more stable currency (e.g. the dollar) to protect their wealth. That is, these countries started to dollarize informally. Eventually, the foreign currency started fulfilling the other two functions of money, i.e. unit of account and medium of exchange. The use of foreign money for domestic transactions is what in the literature is called "currency substitution." Under high levels of currency

[3] Frankel (1999b) adds that no single currency regime is right at all times because the circumstances facing a country can change over time.

substitution or informal dollarization, a flexible exchange rate regime and the use of a domestic currency become less valuable.

Before continuing, it is worthwhile to make some clarifications about the meaning of the terms currency substitution and dollarization. According to Calvo and Végh (1996), currency substitution refers to the use of foreign currency replacing domestic currency in its means-of-exchange function only, while dollarization refers to the use of a foreign currency in any of money's three functions but in particular the store-of-value function.[4] Calvo and Végh present a model based on Thomas (1985) that allows them to conceptually distinguish between the two terms. However, the authors indicate that in the real world, it is difficult to find currency that is used for transactions, that is not considered an asset that fulfills the store-of-value function of money. As Alami (2001) indicates, in developing countries, foreign currency deposits, which are used for transactions, also earn interest rates that are comparable to those in the world markets. When financial markets are underdeveloped, these deposits are among the few options (if not the only option) that citizens have to preserve wealth. Foreign currency deposits are, thus, held for both transactions and portfolio purposes. The focus of this study is on dollarization, which happens when the denomination of both currency and assets changes from domestic to foreign (i.e. when there is both currency and asset substitution.)

According to Calvo and Végh (1996, p. 154), "dollarization is usually the ultimate consequence of high inflation." As mentioned above, a common situation in some developing countries is that citizens begin to use a strong foreign currency, such as the U.S. dollar, to diversify away the inflation risk associated with a weakening domestic

[4] Money can be used as a store of value, a unit of account, and a medium of exchange. See Mankiw (1994, p. 141) for a definition of these three functions of money and some examples.

currency. Craig and Waller (1999) formally investigate the link between inflation and dollarization. Using a one-country, two-currency search theoretic model of money, Craig and Waller show with simple comparative static exercises how higher inflation risk can lead to a nominal depreciation of the domestic currency relative to the foreign currency. The relative loss of purchasing power of the domestic currency, eventually leads to the dollarization of the economy. In their model, the domestic currency is not completely driven out, but it does become much less important in the portfolios of the citizens.

According to Feige, Faulend, Šonje, and Šošić (2003), high levels of currency and asset substitution, which arise as a protective measure by citizens of a country with a continuously depreciating currency, limit the degree of control a Central Bank can have over monetary policy. The main reason for this is that the actual degree of informal dollarization is difficult to measure. The authors indicate that when the degree of informal dollarization is high, the effective money supply is larger than the money supply denominated in domestic currency and is subject to endogenous behavioral responses by the public, which may produce unexpected results to monetary policy. In addition, informal dollarization reduces the Central Bank's ability to use inflationary finance to impose implicit taxes on domestic monetary assets. Furthermore, the fact that dollarization is "informal" creates an environment that encourages tax evasion. The authors consider widespread informal dollarization as an indication of the citizens' distrust of the domestic monetary regime, the monetary authorities, and even the banking system. This issue is relevant to the choice of an exchange rate regime as dollarization. With dollarization, countries are giving up their control on monetary policy. According to

Feige et al., countries that are highly informally dollarized do not have much to lose because they do not have much control over monetary policy in the first place.

Feige et al. (2003), based on network externality concepts from Farrell and Saloner (1986) and Dowd and Greenaway (1993), clearly explain when, under a situation of currency and asset substitution, a country should decide to formally dollarize. Network externalities arise when the decision of a citizen to switch to foreign money depends on expectations about the behavior of other citizens. When informal dollarization is induced by a country's government policy, network externalities tend to reinforce the rewards of holding foreign currency. Under these circumstances, the country's Central Bank has to be aware that a monetary expansion may induce a massive switch out of the domestic currency, which would render the expansion ineffective. If the exchange rate is very sensitive to a monetary expansion, the public is very sensitive to exchange rate changes, and the coverage of the broad domestic money supply by international reserves is low, the monetary expansion will likely produce a run on the domestic currency. If this is the case, the recommended course of action for the government is to either peg the exchange rate to the foreign currency or officially dollarize; otherwise, a *de facto* dollarization of the economy would occur which would be irreversible.[5] If the country dollarizes, network externalities will make sure that it becomes very costly to de-dollarize.

In addition to currency and asset substitution, there is another but related issue that is relevant for the decision of a country to dollarize. With the financial liberalization

[5] In the literature, this irreversibility is sometimes referred to as "hysteresis" of the dollarization process. The idea is that in a country with a prior history of high inflation, the level of dollarization does not tend to fall after the country has been successful in lowering inflation and stabilizing the economy. Feige et al. (2003) suggest that one way to reduce the level of dollarization in the economy is through the appreciation of the domestic currency. The problem is that this appreciation would probably have to be large and sustained for a long time for the results to happen and become stable. In the meantime, the process could result in very high economic and social costs.

process that many Latin American countries have undergone during the past two decades, not only citizens were allowed to keep bank accounts in U.S. dollars, but also banks were allowed to provide dollar loans. This gave rise to a phenomenon that Calvo (2001) calls "liability dollarization." That is, citizens had not only assets but also debt denominated in dollars. As Calvo indicates, private firms with excessive dollar-denominated debt relative to their assets came to play an important role in most of the recent emerging market crises. By contracting dollar-denominated debt, firms with revenues in domestic currency created balance-sheet mismatches that in times of crisis led to their insolvency, which in turn made the crisis even worse.[6] One of the main benefits of a dollarized regime is that mismatches due to currency denomination do not exist.

Caballero and Krishnamurthy (2000) use a three-period model with risk-neutral, competitive domestic firms and foreign investors to provide an explanation about why private firms find it optimal to contract dollar-denominated debt despite the risks that this involves. The main reason is the need of firms to guarantee liquidity to be able to finish their projects when their country has limited access to international financial markets. Calvo (2001) lists three other reasons for the expansion of liability dollarization in the private sector: 1) high currency substitution by the public, which generates dollar-denominated deposits that banks try to match with loans of the same denomination, 2) public-sector liability dollarization; when the government itself contracts dollar

[6] For example, referring to the 1999 Ecuadorian crisis, Beckerman (2002, p. 46-47) indicates that the partial dollarization of the economy "did not *cause* the crisis, but it did intensify the destabilizing effects of exchange-rate depreciation, making the crisis far harder to manage than it would otherwise have been. Partial dollarization meant that the economy was operating internally with two different units of account, subject to an unstable – that is, volatile and uncertain – exchange rate. Exchange rate depreciation […] drove private firms and individuals with open, exposed positions into insolvency. Although commercial banks tried hard to maintain matched positions on their own balance sheets, they apparently took less care to ensure that their borrowers had matching positions."

denominated debt, and 3) some sort of explicit or implicit government guarantee that firms would be rescued if problems caused by currency mismatches arise.

According to Calvo (2001) liability dollarization severely restricts the exchange rate regime options that a government has. Particularly, freely-floating exchange rates are not recommended because then firms that are indebted in dollars become vulnerable to exchange rate volatility. Because this volatility is harmful to the firms, governments find it necessary to intervene and try to control the exchange rate market. Calvo and Reinhart (2000) and Reinhart (2000) refer to this situation as "fear of floating." Calvo and Reinhart indicate that countries that are classified by the IMF as "floaters," do not really float but instead use some sort of non-credible peg. The authors point out that by not making an irrevocable commitment to fix the exchange rate, these countries' governments end up creating high and volatile interest rates, which are negative for economic growth. They suggest that dollarization may reduce uncertainty, causing interest rates to become more stable, and in this way foster development.

Reinhart, Rogoff, and Savastano (2003), in a study of over 100 developing countries for the period 1980-2001, find that those countries with high levels of dollarization experience high inflationary impacts as a result of exchange rate changes. Those countries tend to have a high degree of pass-through from the exchange rate to prices, something that would justify their "fear of floating." Despite this, Reinhart et al. suggest that informal dollarization by itself should not prevent countries from implementing effective monetary policy, and that other related factors may be the real cause for monetary policy efforts to fail in highly dollarized countries. For the authors, however, informal dollarization does greatly complicate the handling of an economy, and de-

dollarizing can result very costly in terms of capital flight and a weakening of the financial system. Informal dollarization could create dangerous currency mismatches, and could greatly complicate the dynamics of financial crises. Highly informally dollarized economies are, therefore, very fragile financially.

2.3. The Limited Exchange Rate Regime Options

Jameson (2001) offers a radical but interesting point of view about the constraints faced by Latin American policymakers when choosing an exchange rate regime. According to Jameson, these constraints are imposed by an "informal but powerful system of norms and principles that ties Latin America to the dominant currency," the dollar. Jameson suggests that Latin America is part of a *de facto* "dollar bloc" that has evolved since the 1970's, in which the exchange rate regime and economic policy in general have been mainly used as an instrument to provide the countries with continual access to dollar inflows. The typical Latin American country is not only highly dependent on foreign funds, but also highly indebted, and servicing its external debt has become a heavy burden. In times of crisis, this burden has often become so unmanageable that the IMF has had to come to the rescue, but not before imposing strict conditions. Jameson suggests that dollarization may have been the only option for Ecuador to guarantee the required stability to regain access to funds from the international markets.

Frankel (1999a, 1999b) suggests a different type of constraint to which economies are subject, the principle of "the impossible trinity." According to this principle, policymakers face three economic goals: 1) exchange-rate stability, 2) monetary independence, and 3) international financial market integration. However, only two of

these goals can be achieved at the same time. Under a purely floating exchange rate system, a country would achieve monetary independence and financial integration, but not exchange-rate stability. With full capital controls, a country would achieve monetary independence and exchange rate stability, but not financial integration. As part of a monetary union, a country would achieve exchange rate stability and full financial integration with the union, but not monetary independence.

With globalization and a worldwide increase in international capital mobility, most countries have been pushed away from capital-control regimes towards pure floats or monetary unions. Frankel (1999a, 1999b) suggests that the tendency is towards complete polarization at either one of these arrangements. Intermediate regimes seem to be falling out of favor for being prone to speculative attacks.[7] Frankel indicates that a country's decision for either regime would depend on its particular circumstances. Small, open economies should consider credibly fixed exchange rate regimes, for example dollarization (a special case of a monetary union), particularly if they need to import monetary stability. Larger, more advanced countries would do better by floating. Countries of intermediate size, not yet sure about their best alternative, may decide for intermediate regimes. These regimes, however, would only be temporary, lasting until the international financial markets start demanding the level of transparency that only the extremes, either free floating or hard pegs, can offer.

[7] Frankel (1999b, p. 6) indicates that "contrary to claims that Mexico, Thailand, Indonesia, Korea, Russia or Brazil were formally pegged to the dollar when they suffered recent crises, these countries were using a variety of bands, baskets, and crawling pegs." According to Beckerman (2002), Ecuador was using a pre-announced crawling peg band system when the financial crisis that started in 1999 forced the monetary authorities to let the exchange rate float. The fragility of intermediate exchange rate regimes is corroborated in a study by Larrain and Velasco (2001).

Larrain and Velasco (2001) agree with Frankel (1999a, 1999b), that free floats and hard pegs are the only viable options. According to Larrain and Velasco, intermediate regimes, such as revocable pegs, cannot resist capital flow reversals. In general, when the authorities try to defend their positions in times of crisis, the situation is made even worse: international reserves are depleted, interest rates skyrocket, and recession becomes imminent. All this produces the destabilization of the financial system.

Larrain and Velasco (2001) suggest that for emerging-market economies flexible exchange rate regimes may be the best alternative. Exchange rate flexibility would be particularly valuable if the economy is prone to large foreign real shocks.[8] These shocks are common for countries with a large foreign debt or that depend heavily on primary product exports. Larrain and Velasco accept that high levels of liability dollarization weaken the case for flexible exchange rates as suggested by Calvo and Reinhart (2000), Reinhart (2000), and Calvo (2001). However, using the results of Céspedes, Chang, and Velasco (2000)[9], they argue that liability dollarization by itself does not prevent flexible exchange rates from playing their insulating role against real external shocks. This argument is also supported by a theoretical model presented in Chang and Velasco (2001). In addition, Broda (2001) shows, using a sample of 74 developing countries, not only that developing countries have been increasingly switching from fixed to flexible exchange rate regimes starting in the 1970s, but also that flexible exchange rate regimes are better insulators of the economy against real disturbances. For fixed exchange regimes, negative real shocks are recessionary, while under flexible exchange rates the

[8] Chang and Velasco (2003) suggest that flexible exchange rates allow the execution of optimal policies.

[9] Céspedes, Chang, and Velasco use a small, open economy model with sticky wages and dollarized liabilities where the real exchange rate is the tool of adjustment and the country risk premium is endogenously determined by the net value of domestic firms. All these elements would make flexible exchange rates destabilizing in the presence of real exchange rate volatility.

path of real output is almost unaffected. Furthermore, contrary to Calvo and Reinhart (2000) and Reinhart (2000), Broda finds that there seems to be no "fear of floating" among the countries in response to terms-of-trade shocks.

However, the case in favor of flexible exchange rates presented in the previous paragraph is not a case against hard pegs such as dollarization. Céspedes, Chang, and Velasco (2000), Chang and Velasco (2001), and Broda (2001) compare floating exchange rates with fixed exchange rates, but dollarization is more than just a fixed exchange rate system. According to Chang and Velasco (2000a), under a fixed exchange rate system the monetary authority stands ready to exchange foreign currency for the domestic currency at a predetermined price. Under dollarization there is no need to defend the domestic currency because the foreign and the domestic currency are the same. In addition, Chang and Velasco (2001) accept that their model, which is based on that of Céspedes, Chang, and Velasco, does not consider issues of credibility, and that in the presence of imperfect credibility, monetary policy under flexible exchange rates could well be counterproductive just as suggested by Calvo (2001). In fact, dollarization is supposed to solve most credibility and time inconsistency problems. With respect to Broda's empirical findings, data availability is obviously the reason for which no comparison with dollarized regimes can be done.

Larrain and Velasco (2001) themselves indicate that country circumstances are also relevant for the choice of the exchange rate regime. For example, if the degree of pass-through from exchange rates to prices is high, flexible exchange rates cannot play their expected insulating role.[10] The degree of pass-through has been shown to depend on

[10] High degree of nominal exchange rate pass-through to prices happens when every movement in the nominal exchange rate causes an immediate adjustment in the domestic prices.

country characteristics such as size, openness, market structure, and degree of competition in the commodities market. It also depends on credibility issues, tending to be high in countries with a history of high and persistent inflation. This in turn depends on the reputation of the monetary authorities. Continuous depreciations of the exchange rate by the authorities create expectations in the public, rendering monetary policy ineffective. Goldfajn and Werlang (2000) investigate, in a dynamic context, the determinants of the inflationary pass-through of exchange rate depreciations using monthly data for a panel of 71 countries for the period 1980-1998. They find that for emerging markets the main determinant is the degree of real exchange misalignment, while for developed countries it is the initial inflation. Other determinants are output deviation and degree of openness. In addition, the degree of pass-through is found to be in general substantially higher for emerging markets than for the developed countries.

If a country is considering adopting another country's currency, ideally after taking into account its economic circumstances, it is important that it also takes into account certain strategic aspects. It is important to peg to the right currency. Larrain and Velasco (2001, p. 12) indicate that "in a world of floating rates, pegging to one currency means floating against most others." For example, adopting the dollar would imply floating against the euro and the yen, with the dollar being able to appreciate or depreciate against those currencies. It is also important to take into account the exchange rate arrangements of neighbors, trade partners and competitors, as they may gain competitive advantage if they can devalue their currencies. These considerations, however, become less important if the pegging country does most of its trading with the country chosen as anchor. In this

situation, adopting the anchor country's currency would actually be convenient in terms of a reduction in transaction costs and the elimination of exchange rate uncertainty.

3. Recent Empirical Developments

Being that dollarization is a relatively new option in the list of available exchange rate regimes, research studies are still scarce. In the initial stages, most studies consisted of arguments about the costs and potential benefits of dollarization. Models were then introduced to support these arguments. It was not until recently that empirical studies started to emerge. Zarazaga (2001, p. 511) accurately described the situation at the moment by indicating that the dollarization debate had "reached a point at which hard-thought numbers might be more enlightening than hard-fought arguments." Due to the nature of the topic, the empirical literature on dollarization is still very limited.

Most of the recent empirical literature has been based on the interest of economists to examine whether dollarization would be a good option for Mexico. That interest seems to have been triggered by the attention that economists and policymakers were increasingly giving to the Argentinean situation in the last few years of the decade 1991-2000. According to Uribe (1997), to end years of high inflation, the Argentinean government launched a stabilization plan in April 1991 that pegged the nominal exchange rate between the peso and the U.S. dollar at a one-to-one parity, eliminated all foreign exchange and capital controls, and required that most of the monetary base be backed by international reserves. This was a currency board system with the dollar as the anchor currency. The positive results were almost immediate, especially in reducing inflation. According to Uribe, the pegging of the exchange rate was not the only reason for this

success. Argentina made its commitment credible by starting an important fiscal reform, a tax reform, a plan for expenditure cuts, a vast privatization program, and a plan for reducing the stock of domestic and foreign public debts. As a result, the fiscal deficit of the government before income from privatizations, fell significantly. However, in 1998 the economy slowed down, and the following years were characterized by negative real output growth and even deflation. In 1999, a re-election year, President Carlos Menem proposed dollarization as the remedy for Argentina's problems. His proposal could not be implemented. In December 1999 Fernando De la Rua succeeded Menem, with Argentina still under a convertibility system and an economy still in trouble; by the end of 2001 the economy was a complete disaster. In January 2002, Argentina formally abandoned its currency board, devalued the peso, and converted all deposits to pesos at the devalued rate (Schuler, 2002.) Although some still considered dollarization an option for Argentina, there was no consensus. Some even believed that the dollar was not the right anchor currency. In fact, by mid 2001 the anchor currency had become a weighted average of both the dollar and the euro. There were others who simply did not believe in a hard peg, and supported free floating.

Alesina and Barro (2001) analyze the pros and cons of dollarization and conclude that countries are better suited to abandon their currencies and adopt that of an anchor country when they not only need to import stability but also trade a lot with the anchor country, are exposed to shocks that are symmetric to those of the anchor country, and their price levels move closely with the price level of the anchor country. Alesina, Barro, and Tenreyro (2002) use these criteria to investigate whether the dollar, the euro or the yen would be the best anchor currency for a sample of countries. Their results indicate

that few countries are compatible enough with the Japanese yen. Among the East Asian countries, only Indonesia shows a reasonable degree of compatibility with the yen. On the other hand, most Africa, and of course the Eastern European countries, show high degree of compatibility with the euro. For Mexico and most of Central America the best anchor currency is the U.S. dollar. For Panama, Puerto Rico and El Salvador, economies that are dollarized, the authors find a very close co-movement of prices with the U.S. Nicaragua is an outlier, because although price and output co-movements are low with all three possible currencies, trade compatibility is better with Europe. Latin America is divided between the dollar and the euro. Brazil may be better served by adopting the euro because output shocks are more symmetric with the euro area. With respect to Argentina, Alesina et al. find that it is unclear whether the dollar or the euro is the best anchor currency, although the euro seems to make the stronger case. The high inflation rates before the 1990's made Argentina a country with a great need for an anchor currency to import stability. However, Argentina has remained a relatively closed economy, and the authors find poor co-movements of prices and output with any of the three potential currency blocks.[11]

Despite the apparent need of Argentina to find the appropriate exchange rate regime, not many formal empirical studies exist about dollarization for Argentina.[12] On the other hand, valuable empirical studies can be found for Mexico. Most studies basically investigate whether the bad performance of the Mexican economy during the past

[11] For Chile the anchor currency is also uncertain, because Chile trades a lot with Europe, but prices and output move a little closer with the U.S. than with Europe. With respect to Ecuador, a country that dollarized in 2000, the authors find it much more compatible with the dollar than with the euro.

[12] Hanke and Schuler (1999) provide one of the few studies. The authors indicate that the Argentinean currency board was not orthodox, which explains the poor credibility of the system. In this study, the authors recommend full dollarization as the solution to this problem, and detail the steps to be followed for its implementation.

decades under policy flexibility justifies the adoption of an extreme exchange rate regime like dollarization. Dornbusch (2001) indicates that Mexico demonstrated unstable economic performance from the 1970s until the end of the century. During this period, the Mexican peso collapsed basically every six years, and inflation was very high[13] creating enormous economic instability. According to Dornbusch, the flexible exchange rate system did not help much. Dornbusch's opinion is that Mexico would obtain enormous gains from adopting a dollar-based currency board.[14] He bases his opinion on the intensity of Mexico's trade with its neighbor, the U.S., the increasing integration between the two countries deriving from NAFTA, and the simple need of Mexico for monetary stability. A currency board would eliminate exchange rate uncertainty, cause interest rates to decrease, and promote even deeper integration with the U.S.

Dornbusch's (2001) point of view is not shared by other studies. Schmitt-Grohe and Uribe (2001) compare the welfare cost of dollarizing the Mexican economy, which they consider equivalent to having a currency board, with the costs of implementing other six monetary policy regimes: money growth rate peg, CPI inflation targeting, non-traded commodities inflation targeting, constrained optimal devaluation rate rule, ad-hoc devaluation rate rule, and stochastic devaluation rate.[15] They use a dynamic model that consists of a small, open economy with sticky prices of non-tradable commodities, with utility-maximizing and infinitely-lived households, with profit-maximizing firms, and a government mainly in charge of running monetary policy. Their model is calibrated to a

[13] According to Alesina, Barro, and Tenreyro (2002), the average rate of inflation for Mexico for the period 1960-1997 was as high as 41%.
[14] This is consistent with the results by Alesina, Barro, and Tenreyro (2002) that Mexico is very compatible with the U.S. dollar block.
[15] The authors measure the welfare costs of business cycles associated with a particular monetary policy regime by the fraction of steady state consumption that households would be willing to give up in order to be indifferent between the steady state consumption and labor supply choices, and those choices under the monetary policy regime in question.

specific seven-year period of the Mexican economy "characterized by a fairly homogeneous monetary policy regime" and a fairly stable rate of devaluation. Although their model does not fit the data very well, the authors still proceed to use it in their analysis to simulate the behavior of the Mexican economy under the alternative exchange rate regimes. Their results suggest that the costliest policy regime is the one with a stochastic devaluation rate, followed by dollarization. The best policy, with almost no welfare cost, is the constrained optimal devaluation rate rule regime. This regime is the best because it takes advantage of exchange rate flexibility to counteract external shocks[16] in the presence of a sluggish adjustment of non-tradable commodity prices, something that cannot be done under a dollarized regime.

Zarazaga (2001) does not agree with the conclusions reached by Schmitt-Grohe and Uribe (2001). According to Zarazaga, the comparison of dollarization to perfectly deterministic policy rule regimes is unfair because these kinds of regimes are far from realistic. In addition, Zarazaga argues that the results based on a calibration of the model for a very restricted period of the Mexican economy cannot be reliably generalized to longer periods, especially if the model does not perform well in predicting the behavior of the economy even during the calibration period. Furthermore, according to Zarazaga, the model of Schmitt-Grohe and Uribe prescribes policy reactions to external shocks that are outrageous.[17] Finally, Zarazaga argues that the specification and parameterization of the model turn the odds against dollarization. Changes in specifications and parameter values could well result in lower costs for dollarization.

[16] Schmitt-Grohe and Uribe identify external shocks, particularly terms of trade and world interest rate shocks, as the main determinants of output fluctuations in the Mexican economy.

[17] For example, under the best policy regime, the model prescribes a devaluation of 26% every time the world real interest rate increases by 1%.

Cooley and Quadrini (2001) concentrate on the welfare effects of dollarization through the inflation channel. According to Cooley and Cuadrini, if the optimal long-run inflation rate for Mexico is higher than that of the U.S., forcing the Mexico-U.S. inflation differential to zero through dollarization would imply welfare losses for Mexico. Cooley and Quadrini use a general-equilibrium, two-country model that is calibrated to the U.S. and Mexico. The monetary authorities in Mexico are assumed to react optimally to the U.S. monetary policy, which is assumed exogenous, by changing the domestic interest rate through changes in the growth rate of domestic money. According to the authors, if the production structure in Mexico is sufficiently dependent on intermediate inputs imported from the U.S., the optimal interest rate for Mexico must be higher than that of the U.S. As implied by the Fisher effect, the optimal inflation rate for Mexico must also be higher.[18] Under dollarization, Mexico would practically adopt the U.S. monetary policy, losing its ability to freely choose the optimal inflation rate, i.e. the inflation rate that would maximize the welfare of Mexican households. In addition, without exchange rate flexibility, Mexico would not be able to optimally counteract asymmetric, real shocks to the economy. The authors indicate, however, that the welfare loss derived from Mexico's inability to counteract asymmetric shocks would be small compared to the loss implied by its inability to set the optimal inflation rate. Cooley and Quadrini recognize that dollarization should not be compared to optimal policies, particularly in the context of a country that has already demonstrated a serious lack of monetary discipline. However, they suggest that rather than directly dollarize, Mexico should try to solve its policy commitment problems first. According to the authors, the observed trends in

[18] According to Mankiw (1994, p. 155), the Fisher effect implies a "one-for-one relation between the inflation rate and the nominal interest rate".

inflation and interest rates during the latter part of the 1990s seem to indicate that Mexico is on the path to solving its discipline problems.

Albanesi and Christiano (2001) give two reasons to disagree with the conclusions of Cooley and Quadrini (2001.) First, According to Albanesi and Christiano, the model of Cooley and Quadrini assumes away the very problem that dollarization is supposed to solve: the time-inconsistency problem. The model has the features to consider the inability of the Mexican authorities to commit to their announced policies, but still they are allowed to adopt the *ex-ante* optimal policy. This puts dollarization at a disadvantage because there are costs associated with the inability to commit that are not being considered for the other policy choices being compared. In addition, the costs of high inflation are not captured in the model. The second reason is that although Mexico is considered an open and small economy relative to the U.S., the model still allows Mexico to control its terms of trade. Changes in the interest rate produce changes in the demand for imports which ends up affecting the real exchange rate. Albanesi and Christiano indicate that the control of the terms of trade through monetary policy is more applicable to economically large countries.

The approaches by Schmitt-Grohe and Uribe (2001) and Cooley and Quadrini (2001) both implicitly assume that Mexico's monetary authorities can implement policies that are optimal and deterministic. However, as indicated by Zarazaga (2001), a complete characterization of monetary policy should include "policy noise." For Zarazaga, the policymaking process is not fully understood and so not deterministic. In addition, the implementation of policy is often affected by uncertainty and time inconsistency

problems, and may have unexpected results. Sometimes, particularly in times of crisis, government intervention itself is a negative factor.

Del Negro and Obiols-Homs (2001) provide some evidence that the Bank of Mexico's monetary policy, rather than a stabilizing tool, has been an additional source of economic volatility. The authors estimate an identified vector auto-regression for Mexico, which is modeled as a small, open economy, using monthly data from September 1976 to May 1997. The estimation procedure takes into account the influence of a foreign sector, represented by the U.S. and the international price of oil. It also takes into account the changes in monetary policy regimes that occurred during the period of analysis. Four regimes are identified: pegged, flexible with predetermined depreciation, crawling target zone, and flexible. The estimation procedure is superior to earlier methods that used single equations or reduced-form vector auto-regressions, or that avoided dealing with the effects of changes in the monetary policy regime. With respect to their results, using variance decompositions for output and price responses, the authors determine that for Mexico: 1) shocks to domestic monetary policy have an unimportant effect on the economy, 2) foreign shocks are the most important source of disturbances for economic activity, and 3) shocks to the oil sector have less importance than shocks to U.S. variables. In addition, using prediction techniques specifically for the aftermath of the December-1994 Mexican crisis, they determine that if foreign shocks had not existed, the observed recession, inflation, and depreciation of the exchange rate following the crisis would not have occurred. This result is consistent with their findings above that Mexico is strongly influenced by shocks to the foreign sector. Del Negro and Obiols-Homs' final analysis consists of determining whether the negative consequences of the crisis would have been

avoided if the Bank of Mexico had not changed its policy due to the crisis. The results of the analysis suggest that the recession and the exchange rate depreciation after the crisis would have been avoided, and that the increase in inflation and the interest rate would have been much milder.

Del Negro and Obiols-Homs (2001) do not address the question of whether dollarization would be preferable to the current Mexican exchange rate regime.[19] However, their results suggest that the response of the Mexican monetary authorities to foreign shocks can be an additional source of instability. Crucini (2001) observes that the periods in which Mexico had more monetary independence were periods of considerably high inflation and long-run depreciation of the nominal exchange rate. On the other hand, when Mexico pegged the exchange rate to the dollar, the inflation rate and interest rate differentials with the U.S. were at their lowest levels. It seems that monetary policy independence for countries like Mexico is related to economic instability. This view would be consistent with Dornbusch's (2001) opinion that dollarization or a currency board with the dollar as the anchor currency could bring not only stability but also better growth prospects for Mexico.

Mendoza (2001) theoretically and empirically justifies the stabilizing effect of dollarization. In his study, Mendoza considers a typical emerging-market economy and tries to determine what benefits may arise from dollarizing that economy. For this purpose, the author uses a dynamic, stochastic general equilibrium model with a two-sector, small, open economy, which is specified so that it has distortions induced by

[19] Another aspect not analyzed by Del Negro and Obiols-Homs is the reason for which the Bank of Mexico decided to change policy when it did. Mexico was using a crawling target zone when, apparently forced by the crisis, it had to let the exchange rate float freely. This move worsened the crisis. The question is: did Mexico have another option? The situation is similar to that of Ecuador when during its 1999 crisis it also had to let the exchange rate float freely to avoid running out of international reserves.

exchange rate volatility and monetary policy, and informational and institutional frictions caused by credit-market imperfections. The model is calibrated to the Mexican economy using quarterly data for the period 1987-1994 during which the exchange rate was managed using a crawling target zone. Mendoza characterizes this system as an exchange-rate-based stabilization plan of uncertain duration. The duration of the plan is uncertain because, although the government announces a commitment to the regime, risk-averse households and firms expect with some probability a switch to a regime with a higher rate of depreciation of the currency and a higher inflation rate. Households and firms base their expectations not only on the past track record of the government, but also on the fact that due to time inconsistency, it is sometimes optimal for well-intentioned, fully rational policymakers to deviate from pre-announced policies. The results of Mendoza's numerical simulations using the model suggest that dollarization has the potential to generate large social welfare gains by providing economic stability. It can do this because it eliminates the problem of lack of monetary policy credibility. Even if credibility remains weak, dollarization can decrease financial frictions and can improve access to international financial markets.

In contrast to Mendoza's (2001) argument, Levine and Carkovic (2001) are skeptic about the direct benefits of dollarization. The authors indicate that the fact that dollarization can eliminate nominal exchange rate volatility and reduce inflation does not guarantee economic growth for the dollarized country unless the country is able to promote financial development. To promote financial development, however, the authors suggest that there are more direct and effective ways than dollarization. For example, the country may implement fundamental legal reforms to strengthen the rights of investors.

The authors base their point of view on the regression results for a panel of 73 countries for the period 1960-1995 that they use to identify the separate effects of exchange rate volatility and inflation on growth. After controlling for country characteristics, the effects of exchange rate volatility and inflation are found to be non-significant. In fact, the effects of both variables are strong and statistically significant until certain country characteristic variables are included in the model. To the authors, this suggests that exchange rate volatility and inflation may have an indirect effect on growth that works through the other variables. They could not identify the specific channels through which the exchange rate volatility variable may be working. However, they noticed that the effect of inflation on growth is strong and negative until the variable for the level of financial intermediary development is added to the regression. The effect on growth of this variable is found to be positive, and strongly significant. The authors conclude that dollarization would not materially promote growth by reducing inflation unless this reduction in inflation boosts financial development. The findings of Mendoza (2001) and Frankel and Rose (1998) suggest that dollarization can in fact facilitate this kind of development.

Some authors oppose dollarization because it eliminates the flexibility that a country may eventually need to ameliorate the effect of idiosyncratic rigidities. This argument is related to the traditional OCA criteria which recommend flexible exchange rate regimes when countries are structurally heterogeneous, as will probably be the case between a small dollarizing country and the large country chosen as anchor. Engel (2001) indicates that the stabilizing properties of an exchange rate regime and its effect on the economy's performance depend on the way prices are set in the economy and the degree of financial

markets development. For a typical emerging market economy, with producers being able to set prices in the currencies of the domestic and foreign consumers, and with an under-developed domestic financial market, there is the possibility that flexible exchange rates may be needed to counteract the effects of monetary shocks; particularly if domestic consumers are very risk averse. However, as domestic consumers find ways to hedge against exchange rate changes, the need for exchange rate flexibility becomes diminished.[20] In addition, Engel's analysis ignores other factors that may be relevant for the choice of an exchange rate regime.

Bercivenga, Huybens, and Smith (2001) indicate that the degree of credit market integration would play an important role on the costs implied by dollarization. The model of Bercivenga et al. implies that if a country dollarizes under a situation of poorly integrated credit markets, the result could be an increase in instability and the possibility of adverse fiscal consequences. The model, however, does not have the right specifications to characterize the typical dollarizing situation. First, it seems more appropriate to explain the situation of two large countries forming a common currency area than of a small country dollarizing unilaterally. In addition, according to Kehoe (2001), the model does not consider the typical problem of time-inconsistent policies. Kehoe's opinion is that the specification of the model is biased against the adoption of a common currency, so that it results in many costs but few gains.

Most studies about the desirability of dollarization compare its welfare implications with those of other alternative regimes. Sims (2001) analysis is different, focusing on the fiscal consequences for a country of adopting the dollar. Sims bases some of his

[20] In countries with incomplete financial markets, i.e. where individuals cannot turn to international asset trading to counteract exchange rate risk, informal dollarization can develop as a substitute.

arguments on the fiscal theory of the price level. According to this theory, a government can keep a stable price level in the presence of sudden fiscal stress, such as that caused by a war, natural disasters, etc., by raising funds either by borrowing or through more taxes. However, these two options are generally difficult to implement or simply impossible politically, particularly for a developing country. When borrowing and taxing are not possible, the government can restore equilibrium in the economy by letting the price level increase. Inflation can, thus, be used as a fiscal shock absorber. According to Sims, dollarization is costly because inflation cannot be used in this way. Sims also argues that in a dollarized economy, sudden fiscal shocks may seriously limit the ability of the government to meet its obligations considering that all its debt would be dollar-denominated. In addition, the Central Bank would not be able to issue currency to bail out commercial banks in trouble. According to Sims, these situations could be handled very well with inflation. These arguments, however, would not persuade any country whose citizens have experienced the effects of persistent high inflation, Mexico for example. Sims himself accepts that recent history suggests that inflation may be becoming increasingly politically unpopular in Latin America.

Another aspect of dollarization of particular interest to Mexico is its potential effect on migration, particularly to the U.S. Borjas and Fisher (2001) investigate how dollarization affects wages and employment in the Mexican labor market. The authors present a one-country, general-equilibrium model where agents can work domestically or abroad, i.e. in Mexico or in the U.S. The model allows changes in the relative wage between Mexico and the U.S. to lead to migration flows. Based on their theoretical model, the authors run regressions to identify the determinants of the number of

apprehensions of illegal immigrants at the U.S.-Mexico border. The data they use are monthly and for the period from January 1968 to December 1996. The results indicate that illegal Mexican emigration to the U.S. tends to increase with decreases in the Mexican real wage or increases in the U.S. real wage. The responsiveness of illegal Mexican emigration to both wages, in particular to the Mexican wage, seemed to be higher during periods when Mexico was under a fixed exchange rate regime. The authors expect a similar situation under a hard peg system such as dollarization. On the other hand, the results indicate that legal emigration is not affected by relative economic conditions between the two countries. This is justified by the rigidity of the U.S. immigration policies. The implication of Borjas and Fisher's study is that if Mexico were to adopt the dollar, illegal immigration to the U.S. would become more responsive to relative wage movements between the two countries – something that is not necessarily bad. If further integration with the U.S. produces a movement toward real wage equalization between the two countries, illegal immigration to the U.S. will experience a significant decline.

4. What to Expect with Dollarization

Despite the recent dollarization episodes and the available research studies, little continues to be known about the consequences of dollarizing. It is known that the dollar can be adopted after a well-thought out cost/benefit analysis as El Salvador did in 2001. Dollarization can also be a rushed, emergency measure used by a country in a situation of crisis to import stability as was the case of Ecuador in 2000. The former case reflects an application of the traditional OCA criteria, while the latter reflects the modern criteria to

support the decision to dollarize. With so few recent cases, not much is known about short-term effects of dollarization. In addition, no matter what prompts a country to dollarize, it is known that once the system is adopted it is very costly to de-dollarize. Dollarization is, thus, a decision for the long run. Still, not much is known about the long-run consequences of dollarization. Much of this is due to data limitations.

Even if dollarization is taken in its general sense, the sample of dollarized countries in the world continues to be small. Table 2.1 shows the list of independent countries that during the period 1970-1998 were using another country's strong currency, excluding the euro-zone members. As reflected in Table 2.1, the list of dollarized countries is very short. In addition, according to their population, most of the countries are too small in size to be considered economically important. Table 2.1 does not contain Ecuador and El Salvador with populations of about 13 and 6 million in 2001, respectively. These two countries present a good opportunity to study short-term effects of dollarization. However, for long-run analyses only Panama qualifies. Liberia could have been the oldest dollarized country, but it was so unstable politically that it had to abandon the system in the 1980's.[21] Data limitations also exclude it from consideration.

4.1. Immediate Consequences

When dollarization started to be presented as an option, it was promoted as the best way to import policy credibility and lower the cost of foreign credit. These are important factors for economic growth, but their effects cannot be observed in the short-run. This section deals with the immediate consequences felt after a country dollarizes, and as

[21] According to Edwards (2001), Liberia abandoned the dollar to avoid the constraints that the dollarized system imposed on the public sector.

expected, there are costs and benefits. At least three costs are known: loss of seigniorage, loss of the typical lender-of-last-resort function of the Central Bank, and loss of monetary policy independence.

Table 2.1. Fully Dollarized Independent Nations in 1970-1998

Country	Population	Currency Used	Since
Andorra	73,000	French franc, Spanish peseta/euro	1278
Kiribati	82,000	Australian dollar, own coins	1943
Liberia	2,900,000	U.S. dollar	1847-1982
Liechtenstein	31,000	Swiss franc	1921
Marshall Islands	61,000	U.S. dollar	1944
Micronesia	130,000	U.S. dollar	1944
Monaco	32,000	French franc/euro	1865
Nauru	10,000	Australian dollar	1914
Palau	17,000	U.S. dollar	1944
Panama	2,700,000	U.S. dollar	1904
San Marino	26,000	Italian lira/euro, own coins	1897
Tuvalu	11,000	Australian dollar, own coins	1892

Note: Other small territories, colonies and self-governing regions use foreign currencies, such as Puerto Rico, American Samoa, UK Virgin Islands, US Virgin Islands, Guam, Turks and Caicos Islands, and Northern Mariana Islands, which use the U.S. dollar. Pitcairn Island uses the New Zealand dollar and the U.S. dollar. Niue, Tokelau, Cook Island use the New Zealand dollar. Cocos Islands and Norfolk Island (Australian dollar), Northern Cyprus (Turkish lira), Greenland (Danish krone), Montenegro (German mark/euro), and Saint Helena (pound sterling.) Source: Edwards (2001).

Chang (2000) indicates that a dollarized country gives up seigniorage revenues, which in turn accrue to the U.S. government. Before dollarization, a country could print units of its own currency at a minimal cost, and purchase commodities (e.g. goods, labor of employees, foreign currency, etc.) or give credit to domestic commercial banks. Under dollarization, the country eliminates its currency and adopts the dollar instead. Because only the U.S. has the right to print dollars, the dollarized country must obtain each dollar

at face value.[22] The importance of the seigniorage revenue, however, will vary with the country. For example, Chang mentions that the average seigniorage revenue for the period 1995-1997 for Brazil amounted to 1.3% of its GDP, constituting almost 9% of total government revenue. On the other hand, the average seigniorage revenue for the period 1993-1997 for Argentina was only 0.33% of GDP, constituting only about 1.7% of government revenue. Obviously, Brazil would find dollarization much less attractive than Argentina. Still, authors such as Sims (2001) believe that the inability to raise revenue through seigniorage could become a heavy burden for any country in times of unexpected fiscal stress. It is obvious that a dollarized country must secure other financing channels and have contingency plans. For dollarization advocates, these are ways to foster discipline and sound fiscal policies.

When a country cannot print domestic money, its Central Bank loses its "traditional" role as lender of last resort to bail out domestic commercial banks in trouble. This is a crucial role to support the confidence that depositors and other creditors have in the financial system. However, two aspects need to be considered before worrying about this alleged cost of dollarization. First, as Chang and Velasco (2000b) argue, even with a Central Bank serving as a lender of last resort, bank runs are only eliminated under a pure flexible exchange rate system. Under an intermediate or fixed exchange rate system where the Central Bank has in addition to defend the domestic currency, its lender-of-last resort function becomes, in effect, very limited. And second, as Chang (2000) indicates, it

[22] According to Berg and Borensztein (2003), the effective loss of seigniorage under dollarization comprises only currency. They indicate that legal reserve requirements on domestic banks also generate seigniorage revenue for the government because these reserves are generally non-interest bearing or remunerated below market rates levels. Under a dollarized system, the Central bank or its successor institution can preserve the ability to impose reserve requirements, keeping in this way this source of seigniorage.

is not that commercial banks will be left unprotected. If the lender-of-last-resort role cannot be accomplished in the traditional way, i.e. by printing money, a dollarized country can always secure lines of credit, for instance, from foreign banks to be used for contingencies. This is, of course, at a cost. According to Chang, under its currency board system, Argentina secured a private line of credit of $6.1 billion for 1996 at a cost of $18 million, i.e. at a 0.3% premium. Berg and Borensztein (2003) indicate that the government of a dollarized country can, in addition, save to create a contingency fund. The availability of emergency funds, however, should in no case prevent the government from implementing other measures to strengthen the public's confidence in the banking system. Among these measures is the use of appropriate bank regulation. Dollarization itself may also help by eliminating the currency mismatch in the banks' positions, and maybe by fostering international financial integration.

The third immediate cost for a dollarizing country is the loss of the ability to implement independent monetary policy. A dollarized country implicitly adopts the U.S. monetary policy, which may not be appropriate if the two countries experience asymmetric shocks or if their business cycles are not synchronized. A flexible exchange rate system is supposed to allow a government to use monetary policy to mitigate the impact of exogenous shocks on output and employment, although at the cost of generating inflation. Under dollarization, the exchange rate is fixed and inflation is not a policy option. The question is whether price level stability is worth the loss of monetary flexibility.

Chang (2000) and Calvo and Reinhart (2000) argue that many developing countries are simply not able to run an effective flexible exchange rate regime, and for that reason,

they would not lose much by dollarizing. These countries cannot lose monetary independence if they do not have it in the first place. Calvo and Reinhart studied the history of exchange rate regimes of 39 countries from 1970 to 1999, and found that those countries that were classified by the IMF as free or managed floaters ran instead systems akin to non-credible pegs. According to Calvo and Reinhart, these countries let their exchange rate float as long as it remained within allowed limits, and the government always intervened to prevent large swings.[23] In addition, Panizza, Stein, and Talvi (2003), using the results from their study on Central American and Caribbean countries, indicate that when countries used flexible exchange rates, they were worse off than when they used fixed exchange rates. Under the former system, the nominal variables experienced large volatility without producing any gains in terms of stability of the real variables.[24] The Central American countries seem to have paid large costs in terms of credibility without benefiting much from the alleged monetary independence. Hausmann, Gavin, Pages-Serra, and Stein (1999, p. 17) indicate that "exchange rate flexibility has not been much of an asset for Latin America. It has not allowed for a more independent monetary policy. It has not permitted a more stabilizing monetary policy. It has produced higher real interest rates and smaller financial systems. It has prompted more indexed wage arrangements, making relative price movements more inflationary."

According to the previous paragraphs, the immediate costs for a fragile emerging market economy that decides to dollarize would not be very important. These costs

[23] For Calvo and Reinhart (1999), the extra degrees of freedom provided by exchange rate flexibility are fallacious when it comes to emerging markets, or can be achieved through other means such as fiscal policy. For details on why countries do not use the purported flexibility of exchange rates, see Hausmann, Panizza, and Stein (2001) and Reinhart (2000).

[24] According to Aliber (2000), the high nominal exchange rate volatility is due to the high volatility of capital flows to the emerging markets.

become even less relevant if the economy is already highly dollarized informally or if wage indexation is common. As indicated by Feige et al. (2003), Calvo (2001) and Hausmann et al. (1999), informal dollarization limits the use that countries can make of monetary policy or exchange rate flexibility, especially because the exact level of informal dollarization is difficult to estimate. Under high levels of informal dollarization, monetary policy can have unwanted results. In addition, Broda and Levy Yeyati (2003) argue that the practical relevance of the losses associated with full dollarization is negatively related with the current degree of dollarization in the financial intermediation system. Rogers (1990) uses a small, open economy model to show that, under flexible exchange rates, the degree of insulation from foreign price shocks may be importantly weakened in the presence of currency substitution. As the foreign currency becomes a closer substitute for the domestic currency, the flexible exchange rate system operates more like a fixed exchange rate system, and the independence in policymaking of the monetary authority becomes limited. That is, once an economy becomes highly dollarized informally, the move to full, formal dollarization becomes more "natural."

It seems that under certain circumstances, dollarizing would bring about more short-run benefits than costs. Under dollarization, a country can relocate resources that were used in the implementation of monetary policy or exchange rate controls to the creation of an economic environment that would encourage future prosperity. For a country like Ecuador, which dollarized in the middle of a severe crisis, the benefits were more evident. Dollarization was successful in stabilizing the economy relatively quickly. After dollarization was adopted in January 2000, and once a transitional period passed, inflation slowed down. During the 1990s, the annual inflation rate averaged about 40%.

In 2002 it became 9.4%, already lower than in any of the previous 20 years, and in 2004 it was just 2%. With the fall of inflation, lending interest rates also fell, and credit rebounded significantly. With respect to real GDP, during 1998 and 1999 Ecuador experienced negative growth due to the crisis that led to dollarization, but after the adoption of dollarization it grew at an annual rate of 2.8% in 2000, 5.1% in 2001 and 3.4% in 2002.[25] Although not the same as full dollarization, the experience of Argentina with its currency board shows certain similarities with the Ecuadorian experience in the short term. The currency board system moved Argentina from a situation of hyperinflation and economic instability to a situation of low inflation and stability. However, the collapse of this system in January 2002 certainly has implications to the Ecuadorian experience. According to Beckerman and Cortés-Douglas (2002), Argentina's clear lesson for Ecuador is that the disciplined management of public finances is crucial for the continued viability of the dollarized system. Sound policies would in fact be more indispensable for a dollarized country because the system does not have an exit option as the convertibility system does.

4.2. Dollarization Effects In the Long Run

4.2.1. Devaluation Risk and Country Risk

The main difference between dollarization and any other exchange rate regime, even a typical fixed exchange rate or a currency board, is its irreversibility. This makes dollarization one of the extremes in the list of available exchange rate regimes, with the opposite extreme being free floating. As it was explained above, it is practically

[25] Source data for figures are the IFS and the EIU country tables.

impossible to find pure free-floating exchange rate regimes among emerging market economies because of the reluctance of their governments to allow large exchange rate fluctuations. They rather use some sort of soft or non-credible pegs. These are intermediate exchange rate regimes, which in a world of high capital mobility can easily become the target of speculative attacks, something that can make international creditors very nervous. According to Eichengreen (2001), history has shown that intermediate exchange regimes collapse sooner or later. Currency boards, although very close to dollarization, still have an "exit" option and can be abandoned at any moment. This was the case of Argentina in January 2002. On the other hand, as Chang (2000) points out, dollarization is much more difficult to reverse. It would be costly, entailing reintroducing a new domestic currency and convincing citizens to turn in their holdings of dollars. The main implication of the irreversible nature of a dollarized system is that the policy arrangement is credible, and in the long run, credibility is supposed to bring many benefits.

Because dollarization is irreversible, devaluation risk is eliminated, at least against the dollar, the anchor currency. As a consequence, inflation tends to decrease because expectations are for the dollar to keep its value. This may be very beneficial for countries with chronic inflation problems. According to De Gregorio (1993) and Fischer (1993), there is a negative relationship between inflation and economic growth, although according to Bruno and Easterly (1998) the direction of causality is uncertain. Bruno and Easterly indeed find that a discrete high inflation crisis is associated with low growth, while the end of such a crisis is associated with high growth, but they regard that more as a short than a long-term effect. Levine and Carkovic (2001) find that inflation does affect

economic growth, but only indirectly. According to Levine and Carkovic, high inflation has a negative effect on growth because it tends to thwart financial development. Under dollarization, low and stable inflation will imply lower and stable nominal interest rates, particularly if there is also further integration of the country's financial system to the international markets. This environment should stimulate investment and economic growth.

The low inflation and the absence of devaluation risk in a dollarized country will definitely produce a reduction in the nominal cost of domestic credit. However, even with domestic loans denominated in dollars, this cost can still be higher than the cost of credit in the anchor country or the world markets. The difference in the cost of credit across countries would be due to what is called a country risk premium, which reflects the probability of a country to default on its international debt. This probability depends not only on the risk of devaluation, which under dollarization does not exist, but also on other country characteristics such as political stability, degree of indebtedness, legal and social conditions, economic vulnerability, and even geographic factors including size, which could be affecting the solvency of the country. As Chang (2000) indicates, the hope of the dollarization advocates is that the elimination of devaluation risk will promote the reduction of country risk, causing the cost of credit to move even lower. According to Berg and Borensztein (2003), lower interest rates and greater stability in the flow of foreign capital would result in not only increased investment, but also a lower fiscal cost of servicing the public debt. This situation would imply a positive feedback that would lower the risk perception of the country.

Other authors, however, believe that the link between dollarization and country risk is not that straightforward. The restrictions imposed by dollarization may increase the fragility of a country and create situations that would amplify country risk. Powell and Sturzenegger (2003)[26] indicate that dollarization not only eliminates the exchange rate as a shock absorber, but also weakens a government's budget by eliminating seigniorage and the inflation tax as revenue sources. This situation may increase the probability of default in the presence of negative shocks to the economy. If, under fiscal distress, the government chooses borrowing as the financing option, then too much debt will add to the risk perception of the country. In fact, this may be why Goldfajn and Olivares (2001) find that, although dollarized Panama has a relatively good country risk rating, this rating is not better than that of some other non-dollarized Latin American countries. In addition, Panama's economy seems not to have been completely insulated against the effects of the financial crises of East Asia, Russia and Brazil during the late 1990s. Furthermore, Panama's economy seems to be equally vulnerable to real shocks as the economy of any other non-dollarized country. This suggests to Goldfajn and Olivares that the absence of devaluation risk alone is not enough to produce further reductions in country risk or to guarantee the cheapest access to international markets. It is clear that the size of the country, its lack of natural resources, and its high level of indebtedness are working against Panama. Goldfajn and Olivares indicate that although Panama has become financially integrated to the U.S., it has lacked fiscal discipline. Under these conditions, it is possible that dollarization has helped Panama keep its relatively good risk rating.

Dollarization may indeed create economic conditions that would lower country risk. Powell and Sturzenegger (2003) indicate that dollarization eliminates the risk of

[26] See also Sims (2001).

speculative attacks on the domestic currency. Berg and Borensztein (2003) argue that the government of a dollarized country would not have to take measures that are necessary to prevent currency crises under other types of regimes – measures that also worsen the risk perception of the country. An example of these measures is the issue of too many dollar-denominated or dollar-indexed bonds, as in Mexico 1994, or the imposition of capital controls, as in Russia 1998. In addition, bank supervision costs are reduced because the currency mismatch between assets and liabilities of banks and firms is eliminated by default under a dollarized system. This mismatch problem is an important source of risk for those countries that are highly dollarized informally. Consequently, under dollarization a country could re-allocate resources more efficiently to pursue needed changes in other crucial aspects. A country may pursue international financial integration or the implementation of more disciplined fiscal policy.

4.2.2. Overall Performance

According to Salvatore (2001) a good candidate country for dollarization is a small, open economy for which the U.S. is the prevailing trade partner; an economy with a history of poor monetary performance and low policy credibility; an economy with practical limitations to conduct an independent monetary policy to counteract shocks to the economy; a risky, unstable economy that faces much higher interest and inflation rates than does the U.S., and that is vulnerable to speculative attacks to its currency. Dollarization advocates suggest that the formal adoption of dollarization would solve

most of this economy's problems.[27] Stability and credibility would be imported from the U.S. through the sound currency, and the stable economic environment would promote changes that are needed for growth. Among these changes are reforms in the banking system, fiscal policy, and the labor market (Eichengreen, 2001.) That is, dollarization seems to promise a significant improvement in economic performance for the type of country described by Salvatore. However, the validity of that promise cannot be evaluated empirically because of the lack of data. Long-run analyses for the experiences of Ecuador, El Salvador or even the European Monetary Union are not feasible yet. Only the experience of Panama, a country that has been dollarized since 1904, can shed some light on this matter.

Moreno-Villalaz (1999) presents a comprehensive description of the long-run experience of Panama under dollarization. The author indicates that Panama has achieved full international financial integration, and "has shown remarkable economic stability, an ability to handle large capital inflows and to adjust to shocks without major disequilibria, and no distortions in macro-prices."[28] Interest rates have remained at world market levels, and the economy has not suffered policy-induced macroeconomic crises or systemic banking crises. The economy has not shown the need for the Central Bank as a lender-of-last-resort. In fact, Panama does not have a Central Bank at all. There is no deposit insurance or reserve requirements on commercial banks. With absolutely no restrictions on capital mobility, the money supply is market driven rather than government determined. According to Moreno-Villalaz, Panama has a purely-competitive-market

[27] Calvo and Mendoza (2000) indicate that "in one shot" dollarization removes the need for a country to learn how to manage its exchange rate, and mitigates the severe credibility problems faced by policymakers in emerging market economies.
[28] See the conclusion of Moreno-Villalaz (1999, p. 437.)

monetary system under which the financial market gives the right price signals to the economic agents. With respect to monetary policy, U.S. policies affect Panama by affecting the world's supply of dollars and the world's interest rates, in a similar way as they affect any other country, but without distortions.

Goldfajn and Olivares (2001) study Panama's performance compared to Latin America as a whole, to Argentina under its currency board, and to Costa Rica, a non-dollarized country. They find that Panama's inflation rate and inflation volatility have both been remarkably low. Interest rates have also been low, due in part to a very competitive banking system. Panama's financial system is highly internationalized, due probably to the absence of a Central Bank as lender of last resort, which has induced financial agents to seek alternative sources of contingent funds. Despite this, spreads on foreign debt bonds, although low, are not the lowest in Latin America, indicating that country risk has declined only partially under dollarization. An econometric exercise allows the authors to determine that general confidence shocks have a smaller effect on Panama than on other countries, but that real shocks have the same effect. This suggests that dollarization may offer some protection against contagion but not against real foreign shocks. Finally, Goldfajn and Olivares, observe that Panama's fiscal performance has been poor. The country has accumulated a very high public debt and has even had problems meeting external obligations. Since 1963 Panama has been the beneficiary of more IMF programs than any other Latin American country. The fiscal "straight-jacket" supposedly imposed by dollarization seems not to have played a role for Panama.

Edwards (2001) studied other dollarized countries in addition to Panama. For this, Edwards uses the general definition of dollarization, i.e. with the countries using a

foreign strong currency not limited to the U.S. dollar. Edwards tries to determine if the countries have achieved the benefits attributed to dollarization, i.e. fiscal discipline, lower inflation, and faster growth. The author compares the historical performance of a group of 11 dollarized countries with that of two other groups of non-dollarized countries.[29] The results indicate that, when compared to the other countries, the dollarized countries have lower per-capita GDP growth, higher GDP growth volatility, lower inflation, and similar fiscal deficits and current account balances. An important caveat to these results, however, is that the dollarized countries used by Edwards are very small, most of them with less than 100,000 inhabitants and with limited resources. Comparing these minute and fragile countries to the much larger non-dollarized countries may simply not be fair.

In addition to the general results for the group of dollarized countries, Edwards (2001) has specific observations for Panama. The author emphasizes the country's heavy reliance on the IMF during the last 35 years or so. It seems that until recently, Panama had not been able to put its fiscal accounts in order. Edwards also indicates that in 1988-1989 Panama suffered a major systemic banking crisis due to the weak financial position of most state-owned and private commercial banks.[30] Edwards mentions that Panama has successfully shown its commitment to the dollarized system, and has obtained low-cost access to capital in international financial markets, but its country risk rating is still not better than that of other Latin American countries such as Chile for example. In addition, external shocks, such as terms-of-trade disturbances and current account reversals, have

[29] See Table 2.1, in section 4 of this chapter, for the list of dollarized countries. Edwards' two comparison groups are a group of emerging and advanced countries, and a group of only emerging countries. The two groups comprise countries that never had a dollarized or a currency board system, but that had any other type of exchange rate regime (floating, crawling, pegged, etc.)

[30] However, this event may not be that relevant because the period 1987-1989 coincides with the Noriega political and economic crisis induced by tensions between Panama and the U.S.

generated higher costs in the form of lower investment and slower GDP growth in Panama than in the average non-dollarized country. Despite all this, for the period 1955-1998, Panama had a very low average annual inflation rate of 2.4%, and a healthy average annual real GDP growth rate of 5.3%.[31] The lesson of these findings seems to be that, although dollarization may be of valuable help for a fragile country, it is not by itself a guarantee for economic success.

4.2.3. Integration with the Anchor Country and Survival of the System

Eichengreen (2001) indicates that the restrictions imposed by dollarization should induce the dollarized country's government to implement economic reforms that would foster economic growth. If before dollarization, economic limitations did not let it achieve economic stability, after the adoption of dollarization and under a stable environment, it should implement reforms that compensate for those limitations. For example, it should strengthen the banking system with financial reforms. Furthermore, considering that under dollarization the inflation tax is not an option and seigniorage revenue is limited, the government should also implement fiscal reforms so that it will be able to live "within its means." The most difficult set of reforms to implement may be those to introduce flexibility in the labor market or to compensate for the lack of it. In emerging market economies, devaluation and inflation are typically used to compensate for the lack of flexibility in the labor market. Under dollarization, these policy tools are not available, making labor market reforms indispensable.

[31] Panama's average annual real GDP growth rate is similar to that of the non-dollarized countries for the same period. For Moreno-Villalaz (1999) Panama's performance could have been better if it had not been for remaining tariff barriers and laws that have made wages unnecessarily rigid.

Banking system reforms that promote financial development are crucial for a dollarized country to achieve close integration to the international financial markets. According to Berg and Borensztein (2003), Panama has been extremely successful in this aspect, particularly since a major financial liberalization in 1969-1970. Moreno-Villalaz (1999) argues that under financial integration with the world markets, the Central Bank is not necessary as lender of last resort because international banks can fulfill this role. Deposit insurance, government guarantee to banks, and reserve requirements on deposits are not necessary either. In fact the Central Bank is not necessary at all because under dollarization no independent monetary policy can be run. Furthermore, with complete access to the international markets the cost of credit is lower than when the access is limited, and competition among international and domestic banks helps keeping the interest rates low.[32] According to Moreno-Villalaz, despite the criticisms about the poor fiscal performance of Panama, the fact that the country has been able to run fiscal deficits is an indication of the confidence of the international markets in Panama.[33] Moreno-Villalaz also praises the transparency of Panama's financial market in which the government does not intervene. This situation eliminates price distortions that cause economic agents to make erroneous decisions. Finally, with financial integration, banks in Panama run more efficiently by using internationally accepted standards of operation.

Financially may be only one of the ways a dollarized country can become more integrated to its anchor country. Berg and Borensztein (2003) suggest that dollarization

[32] In addition, Frankel (1999b) indicates that changes in the U.S. interest rates during the 1990s had less effect on the interest rates in Panama than in other non-dollarized countries. According to the results of Frankel's analysis, when the U.S. federal funds rate rose by one basis point, the Mexican interest rate rose by more than 15 basis points, and the Argentinean interest rate (under the convertibility system) by between one and almost three basis points on average. For Panama, the interest rate increase was of only 0.43 basis points on average.

[33] However, Dornbusch and Reynoso (1989, p. 206) indicate that "deficit finance is a hazardous means for promoting growth" particularly if it governs the growth of the money supply, or if it is overdone.

may contribute to a broader economic integration to the U.S. to an extent not possible otherwise. According to Frankel and Rose (1998) a dollarized country may benefit from what they call the "endogeneity" of the OCA criteria. By this, the authors mean that even if a country dollarizes without fully satisfying the conditions for a successful common currency area, over time these conditions can become satisfied. For example, if the dollarized country and the U.S. did not trade much originally, trade should increase, and with trade integration, a better business-cycle co-movement between the two countries should develop compensating any initial disparity. In a sense, the use of a common currency may tend to compensate for the existence of a border, i.e. the political or physical separation, between the countries.

Berg and Borensztein (2003) cite McCallum (1995) to indicate that national borders have a negative effect on the trade intensity between countries that is in addition to the effect of transportation costs. In an analysis of Canada-U.S. trade patterns, McCallum finds that, after correcting for distance and other factors that affect trade, Canadian provinces trade more with each other than with U.S. states that are geographically closer. That is, trade integration is greater within a given country than across countries. A similar result is observed for the degree of price integration. Engel and Rogers (1996), find that after controlling for distance between cities, the presence of the border between Canada and the U.S. raises the time variability of the relative prices of commodities. Berg and Borensztein suggest that the cross-country lack of trade and price integration could be due to the use of different currencies in the two countries, particularly considering that there are no other important restrictions to trade between the U.S. and Canada. In fact, Parsley and Wei (2001), in a study of relative prices between the U.S. and Japan for the

period 1976-1997, find that exchange rate variability is an important factor explaining the volatility over time of the relative prices of commodities between the two countries.

Recent empirical studies have found evidence that there is a positive effect of the use of a common currency on the trade and business cycle integration between countries. Rose (2000) applies a gravity model to a cross section of 186 countries and territories and finds that, after controlling for other factors affecting trade, two countries sharing a common currency trade about three times as much as countries not sharing a common currency.[34] Several other studies corroborate the positive effect of a common currency on trade, although with a different size for the estimated effect.[35] Frankel and Rose (2002) find, in addition, that the adoption of a common currency does not imply trade diversion. Glick and Rose (2002) find that a country that leaves a currency union could experience declines in bilateral trade. Alesina, Barro, and Tenreyro (2002) find that, in addition to increasing bilateral trade, the use of a common currency raises the co-movement of prices between the countries. These findings, together with that of Frankel and Rose (1998), that cross-country trade integration has historically been associated with cross-country synchronization of business cycles, suggest that the use of a common currency under a dollarized system can become more sustainable over time.[36] In fact, Corsetti and Pesenti (2004) suggest that business cycles would become more synchronized even in the absence of further trade or real economic integration. Under a credible common-currency

[34] The common-currency effect is an order of magnitude larger than the effect of reducing exchange rate volatility to zero while retaining two different currencies.

[35] See Table 8 in Alesina, Barro, and Tenreyro (2002) for a list of these empirical studies.

[36] Takagi, Shintani, and Okamoto (2003), using the unique experience of Okinawa, find that during the periods when Okinawa was in a monetary union with the U.S. and Japan the variance of its relative price levels with Japan and the U.S. was smaller, and its business cycle linkage with the two countries was stronger than before the monetary union. In addition, the incidence of asymmetric nominal shocks in Okinawa was smaller when it was under a monetary union with Japan than before. The results with Japan may be more the consequence of policy efforts of Japan to integrate Okinawa. However, the results with the U.S. point more to an effect of real convergence as a consequence of a monetary union.

regime, firms adapt their pricing strategies to the new economic environment in a way that even if the countries are subject to asymmetric shocks there is no need for an asymmetric or independent policy response. Corsetti and Pesenti argue that a common-currency system between two or more countries may be self-validating. The system fosters a better correlation of national outputs, and a common monetary policy is enough.

The continuous viability of the common-currency system is reinforced if the integration with the anchor country promotes economic growth. In this sense, the findings of Frankel and Romer (1999) are encouraging. Using a sample of 63 countries, they find that trade has a positive effect on income: increasing the trade to GDP ratio by 1% raises per-capita income by 0.5 to 2%. The size of the country size may have an amplifying effect, with larger countries having more trade opportunities and so more potential for income increases. Frankel and Rose (2002), based on a sample of over 200 countries and territories, find that a 1% increase of the trade to GDP ratio is expected to produce an increase in real per-capita income of at least 0.33% over a period of 20 years, and possibly more over the longer run. Rose and van Wincoop (2001) argue that national currencies are significant barriers to international trade, and that if countries adopted a common currency, they could expect substantial increases in welfare. The expected welfare effect is positive because fewer resources would be wasted on the transaction costs of trade.

Despite the advertised benefits associated with dollarization, there are certain factors that could threaten the survival of the system. In this respect, Corden (1993) provides certain requirements that must be met to prevent an eventual collapse of the regime. The exchange rate commitment achieved by dollarization must succeed in bringing about

discipline in government financing and credit creation. Lack of fiscal discipline will translate into falling international reserves or too much indebtedness, which, even in the absence of speculation may lead to crises and pressures to abandon the system. Any lack of discipline will be incorporated into the risk perception of the country by international financial institutions – an effect that will prevent interest rates from moving lower. Another requirement is that the government avoid labor market rigidities which prevent real adjustments when adverse shocks hit the economy. Sachs (1996) indicates that a permanently pegged exchange rate regime like dollarization is appropriate for very small, open economies as long as they have a high degree of wage or price flexibility so that nominal variables can quickly adjust to exogenous shocks. However, wage and price flexibility are not common in emerging markets. In addition, considering that economic fluctuations are more severe in these markets, as suggested by Crucini (1997), a dollarized country should take into account this requirement very seriously.[37] Under a dollarized system, a government should modernize and take measures that promote productivity growth or be willing to accept a depreciating relative price of their services.

If the steps that a country takes to guarantee the survival of its dollarized system are the same ones that guarantee its economic well-being, why is that this country does not take the same steps without turning to dollarization? Rogoff (2001) argues that forming monetary unions or adopting common currencies is not necessary to achieve efficiency, policy discipline or international integration. According to Rogoff, the long-term benefits

[37] Chang and Velasco (2000a, p. 73) indicate that "if a real depreciation is called for because of an external shock, it will take place regardless of the exchange-rate system. Policy will only determine the manner of adjustment. Under flexible exchange rates, the change in relative prices occurs suddenly and sharply; under fixed rates or a currency board, the real depreciation will have to take place slowly, as nominal prices fall." Beckerman and Cortés-Douglas (2002) consider that, in addition to the inability of the government to control its fiscal accounts, a highly appreciated real exchange rate had a very important role in Argentina's recession. Under the convertibility system, the only option to depreciate the real exchange rate was through wage and price-level reductions, something that Argentina was structurally unable to undergo.

attributed to the use of a common currency would be, in fact, the result of the actions taken by the countries concurrently to the adoption of the new regime. As an example, Rogoff indicates that while working towards their union, the European countries were taking important steps toward economic integration, such as standardization or supervision and regulation of banks and financial intermediaries, but those steps are not the result of the union. The author cites the old fable of the nail soup as an analogy: "A beggar, trying to talk his way in out of the cold, claims that he can make a most delicious soup with only one nail. The farmer lets him in, and the beggar stirs the soup, saying how good it will taste, but how it would taste even better if he could add a leek. After similarly convincing his host to contribute a chicken and all sorts of other good things, the beggar pulls out the magic nail, and indeed, the soup is delicious." Rogoff suggests that, just like the nail, the euro is not necessary, and that what matters are the other ingredients. Similarly, dollarization should not be necessary for the countries to achieve economic stability. However, Rogoff is overlooking two things. First, that credibility is what plays a crucial role in dollarized or common currency systems. Countries are either forced or willing to make great sacrifices when they believe that there is no other option. And second, that the nail was what got the beggar out of the cold, not the ingredients.

5. Conclusion

Dollarization, the adoption by a country of a strong foreign currency as its own, has recently become an exchange rate regime option for emerging market economies. It is an important one considering that in a world of high capital mobility, regimes that are intermediate between a hard peg and a free float seem to be destined to collapse sooner or

later. Intermediate regimes may quickly gain the distrust of both domestic and foreign economic agents. For the typically fragile emerging market economy, exchange rate flexibility may be more likely to introduce extra instability. Under these circumstances a hard peg may be the best option.

The consensus in the literature seems to be that large countries that are able to implement sound and credibly policies should float their exchange rate. These countries would be able to run independent monetary policy to counteract shocks to their economies. However, fragile countries with a history of devaluations, inflation, slow growth, and an inability to run independent and credible monetary policy, may obtain large benefits by dollarizing. This would be particularly true if their fragility is a reflection of economic circumstances such as small size, high degree of openness and nominal exchange rate pass-through to prices, pervasive currency substitution and informal dollarization, or high degree of indebtedness. In fact, these are also factors that impose severe limitations to the authorities' ability to run independent monetary policy. They cannot practically implement a truly floating exchange rate regime, and end up using soft pegs which are likely to suffer speculative attacks. As a result, the risk rating of the country worsens and interest rates and inflation both rise thwarting the development of the financial system which has negative effects on economic growth.

Dollarization offers these poorly performing countries an option to import monetary stability and credibility, and to become integrated with a large stable nation. They can adopt dollarization unilaterally even without satisfying all the conditions for a successful system. Over time, trade integration, business cycle synchronization, and price and income correlation should increase the sustainability of the system. If in addition, the

authorities implement key legal, fiscal, financial, and labor reforms, risk ratings will improve allowing a smoother development of the financial system. While modernizing the economic structure, the authorities can continue promoting productivity growth and productive diversity, and devising fiscal mechanisms that make the countries more resilient to real domestic and foreign shocks.

Apparently, for the small fragile countries just described all the promised benefits from dollarization are at a low cost. The most important benefit seems to be that the government is forced to "live within its means." That is, it should look for forms of financing other than printing new money. In this sense, dollarization is supposed to impose a "straightjacket" to a country's fiscal management. Although some authors believe this inflexibility could threaten the stability of the system in times of crisis, others believe that for certain countries, it is the only way to prevent abuse and mismanagement of policy tools such as seigniorage and inflation. The credibility and irreversibility of the dollarized system are the best deterrents. Other costs could be identified for a system like dollarization if the system is compared to optimal exchange rate regimes. However, these optimal regimes are not realistic or viable, particularly for the very fragile emerging-market economies.

Still, dollarization by itself is not a guarantee for complete economic success, an example being Panama's experience with that system. Panama's price stability has been outstanding, but its economy has not been able to grow more than the typical Latin American country, and its credit rating is not one of the best. Economic growth does not depend only on the exchange rate regime but also on the appropriate actions taken by the government. But, dollarization is not an unnecessary move as Rogoff (2001) suggests.

For certain countries, many of the reforms and steps considered under dollarization would not be considered otherwise. According to Frankel and Rose (1996) dollarization is endogenous in the sense that if it is not the best exchange rate regime for a country initially, it can become more so over time. As implied by Frankel (1999b) and Corcetti and Pesenti (2004), it is the country and its economic agents that change and adapt to the new and credible system. These adjustments, in turn, contribute to the sustainability and potential success of the system.

CHAPTER III

DOLLARIZATION AND PRICE DYNAMICS: THE CASE OF ECUADOR

1. Introduction

This chapter discusses Purchasing Power Parity (PPP), the Law-of-One-Price (LOP) and relative price dynamics in the context of Ecuador, a country that recently adopted the U.S. dollar as its official currency. While a number of other countries, such as Argentina and Mexico, have discussed this currency option, Ecuador and El Salvador are the only sovereign nations that have done so recently. Panama is also an interesting case, having dollarized in 1904, but comparative analysis with Ecuador is problematic because the two episodes are set in such different global circumstances, and data are difficult if not impossible to obtain. Similar limitations exist in the case of El Salvador.

Ecuador adopted dollarization after experiencing a very severe economic crisis during 1999. In 1993, after a long history of volatility, the nominal exchange rate started to be managed more consistently, and the real exchange rate became quite stable. However, this changed markedly during the late 1990s, particularly in 1998, when the economy was rocked by a number of external shocks: a significant drop in oil prices (oil being a key export), foreign financial crisis in Southeast Asia, Russia and Brazil, and extensive damage to agriculture and infrastructure by El Niño.[38] These shocks led to a deteriorating fiscal situation in the government, bank insolvency and runs, and finally, a

[38] Beckerman (2002) mentions these shocks as the triggers of the pre-dollarization Ecuadorian crisis, and explains why certain economic and political characteristics made the country particularly vulnerable to these shocks.

rapidly depreciating currency. During 1999, the dollar value of Ecuador's sucre fell by about 64%, and the level of prices in Ecuador fell by about 50% relative to those in the U.S. In one of the boldest moves in recent history, the government of Ecuador adopted the dollar as its official currency in January 2000.

Following this move, inflation accelerated somewhat and relative prices (i.e. the real exchange rate vis-à-vis the U.S.) moved rapidly back toward the levels that existed prior to the currency crisis. The currency and financial crisis was accompanied by a deep and short-lived recession (GDP growth was about -6.7% in 1999 and was 2-5% in 2000 and 2001 according to the World Bank) and a swing in the current account from surplus to deficit, patterns not unlike those experienced in Southeast Asia during the 1997 crisis. One key difference, though, is the rapid recovery of the relative prices and the stability of the price level and inflation following the crisis and recovery, which is apparently due to the move to dollarization.

The behavior of Ecuadorian real exchange rates is examined in this chapter in relative and absolute terms before, during and following the recent currency crisis. A novel feature of the analysis is the use of data at the level of individual goods in 12 major cities within Ecuador, as well as the more conventional CPI data. The micro-data allow the comparison of the level of prices in Ecuador to the U.S. before and after the turmoil of currency crisis and dollarization. They also permit a study of the impact of currency fluctuations and regimes on price dispersion across goods among Ecuadorian cities and relative to the U.S.

This chapter is organized as follows: Section 2 describes the data sources and variables used in the analyses. Section 3 examines the stationarity of real exchange rates

between Ecuador and the U.S. and their half-lives using both the CPI and the micro-data. In particular, the importance of trend breaks for these issues is explored where the break dates correspond to the start and end of the currency crisis and the onset of the new price equilibrium. When the breaks are not used, the results point to group stationarity of the micro-price real exchange rates and average half-lives of about one year, much less than the PPP literature consensus of three to five years for cross-country studies.[39] When the breaks are used, the stationarity results are much stronger and the average half-life estimates reduce to just about two months.[40] Section 4 drills down to the level of individual goods prices across Ecuadorian cities and questions how the currency regime or volatility of the currency affects intra-national relative prices. When the country's capital city is taken as reference, signs of increased price level integration are found, but the results do not imply overall cross-city integration. However, price integration in terms of reduced relative price volatility is found in both the international and the intra-national contexts. These results are consistent with the literature on integrating effects of the use of a common currency.[41] Section 5 concludes.

2. The Data

Two analyses are conducted: one international, described in section 3, and the other intra-national, described in section 4, both using micro prices. The main source of data is the National Institute of Statistics and Censuses of Ecuador (with acronym INEC in

[39] See Rogoff (1996). For a good compilation of the PPP literature, see Froot and Rogoff (1995.)
[40] Results in Parsley and Wei (1996) suggest half-lives between 12 and 15 months for the relative prices of tradable goods across U.S. cities. Crucini and Shintani (2002) find half-lives between 9 and 12 months for relative prices across countries and within national borders of several countries. Both studies use micro-prices.
[41] See, for example, Frankel and Romer (1999), Frankel (1999b, 2001), Rose (2000), Frankel and Rose (2002), and Glick and Rose (2002), among others.

Spanish.) The data consist of monthly prices of 223 commodities for 12 Ecuadorian cities, including the capital city Quito, for the 76 months from January 1997 to April 2003. For a sub-set of 152 commodities, the series are longer, starting in January 1995. The commodity-level time series are also available for the national average city. These are the actual data used in the calculations of the Ecuadorian CPI during that period.

For the international analysis, between Ecuador and the U.S., 23 commodities (21 basic food items, plus electricity and gasoline) are chosen from a much larger set of 116 commodities in the U.S. and the 223 commodities in Ecuador on the basis of carefully matching the definitions of the goods as closely as possible.[42] The underlying commodity prices themselves are national averages.[43] The U.S. data were obtained from the Bureau of Labor Statistics (BLS) website.

The selected set of commodities is small due to a number of data limitations. First, the BLS publishes price data for food, household fuel, and motor fuel items, but does not publish prices for durables or services because they are not homogeneous over time. Second, the BLS list of items is not as extensive as it first seems; different varieties of the same commodity make the list long.[44] Finally, some commodities in one list are not in the other, and for some that are in both lists, the time series of prices is too short or incomplete. Prices for the 100 months from January 1995 to April 2003 are required.

For each of the selected commodities, the relative price between Ecuador and the U.S., $q_{j,t}$, is calculated as:

[42] For some commodities, unit conversions are needed (i.e. kilograms are converted to pounds; gallons to liters; etc.) The symplifying assumption made is that that prices change proportionally with size. Also, a few interpolations are needed for some of the U.S. price series.
[43] National average prices are weighted average prices for each commodity where each city in the country has a weight that depends on the city's consumption.
[44] For example, there are 5 types of bread, 9 types of coffee, 9 types of steak, 5 types of milk, and so on.

$$q_{j,t} = p_{j,t} - e_{j,t} - p^*_{j,t} \quad (3.1)$$

where $p_{j,t}$ is the sucre national average price[45] of commodity j in Ecuador (j = 1, 2,…, 23), $p_{j,t}$* is the dollar national average price of the same commodity in the U.S., and $e_{j,t}$ is the nominal exchange rate in sucres per dollar. The subscript t is for the month (t = 1, 2,…, 100), and all variables are in logs. In addition, the relative price of the average commodity is calculated as the simple average of the 23 $q_{j,t}$ series. This 24th series is analogous to the aggregate CPI-based real exchange rate.

For the intra-national analysis, only the INEC data as described above are needed. However, the period of analysis is restricted to be the 76 months from January 1997 to April 2003 because it allows the use of the most comprehensive sample of commodities (223 versus 152 available from January 1995.) For this analysis, commodity-level relative prices between 11 Ecuadorian cities and the capital city Quito are calculated in the following way:

$$q_{i,j,t} = p_{i,j,t} - p_{Quito,j,t} \quad (3.2)$$

where $q_{i,j,t}$ is the relative price in month t, of commodity j, between each city i and Quito. On the right hand side, $p_{i,j,t}$ and $p_{Quito,j,t}$ are commodity j's sucre prices for city i and Quito, respectively. All variables are in logs. We have i = 1, 2,…, 11 cities, j = 1, 2,…, 223 commodities, and t = 1, 2, …, 76 months, so the total number of relative prices calculated is 186,428 (16,948 for each city.) Using these data, two summary series are calculated for each city. One is $q_{i,t}$, the relative price level series for city i, obtained as the simple average of the 223 commodity $q_{i,j,t}$ series for the city. The series $q_{i,t}$ can also be interpreted as the relative price for the average commodity in the city. The other

[45] The analysis was repeated replacing the national average price with the price in each Ecuadorian city one at a time. The results did not change significantly.

summary series is $s_{i,t}$, the spread of the commodity relative prices around the $q_{i,t}$ series of city i, calculated as the standard deviation of the 223 commodity relative prices at each month t for the city.

2.1. Descriptive Statistics for the Aggregate Real Exchange Rate

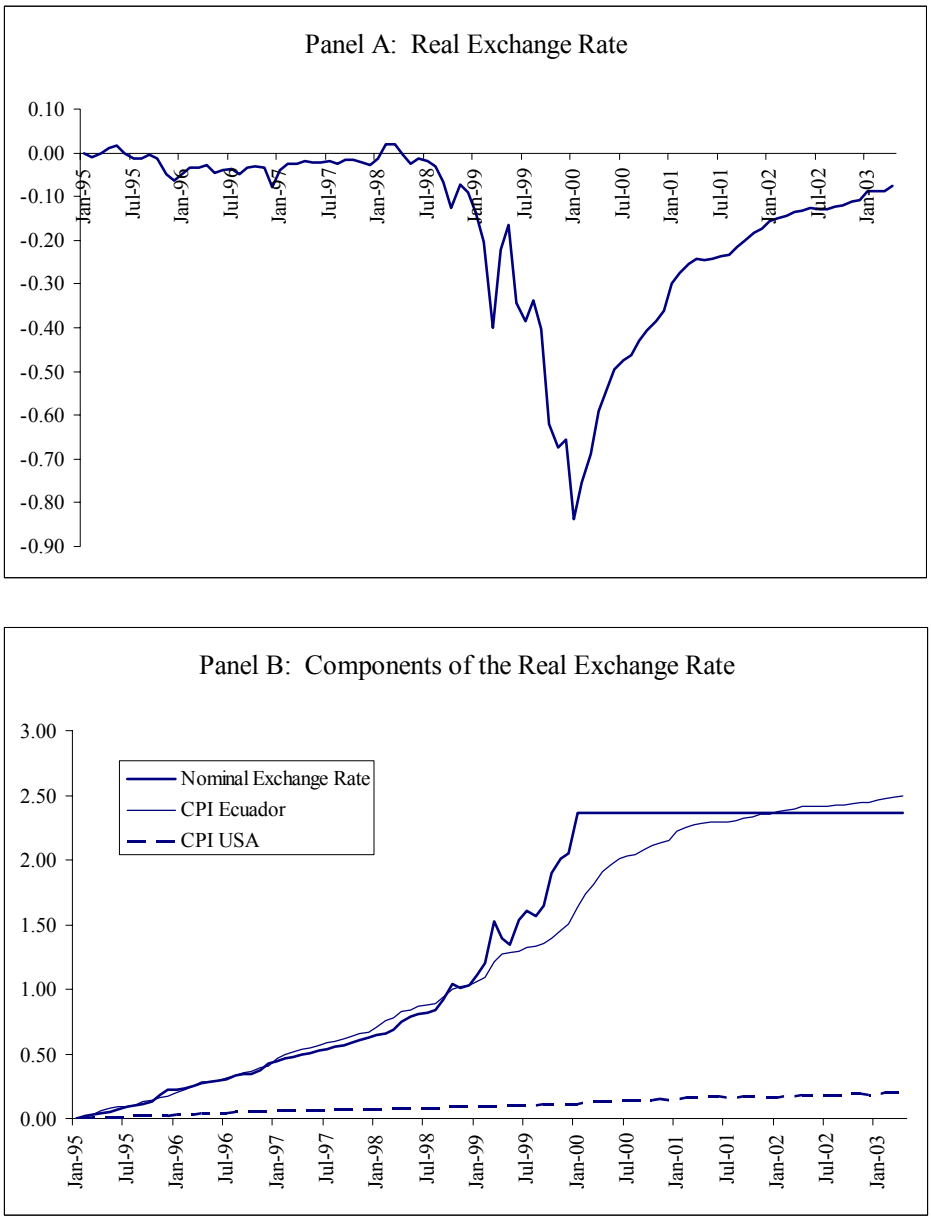
Before describing the micro-data or delving into the analyses' formal statistical modeling, it is useful to present some basic information about the standard measure of relative price between Ecuador and the U.S., the CPI-based real exchange rate (RER.) The RER is defined as the ratio of the CPI of Ecuador to the U.S. CPI divided by the nominal exchange rate in sucres per dollar, all of which are obtained from the IMF International Financial Statistics (IFS).

The scope of the Ecuadorian 1999 crisis, which as indicated above was caused by exogenous shocks, and the stabilization phase are clearly reflected in the behavior of the RER.[46] Panels A and B in Figure 3.1, plot the RER and its components, all in log terms, for the period from January 1995 to April 2003.[47] For simplicity, all series are re-based to January 1995 before being plotted, so that an implicit assumption is that PPP held in that month. Figure 3.1 indicates that from January 1995 to December 1998, the sucre depreciated about 100% versus the dollar, while the Ecuadorian price level increased also about 100%. With a U.S. accumulated inflation of less than 9% during that period, this

[46] The behavior of the RER was also affected by the deep recession and the resulting unemployment. Another factor was government intervention. In March 1999, and amid a succession of bank failures, the government declared a one-year general deposit freeze. Deposits were released at a very slow pace during 1999 and the coming years. In addition, the deposit insurance agency was sluggish in giving back to the public the deposits held by failed banks.

[47] This period is used because it is the one used in the analyses of sections 4 and 5.

indicates that relative PPP held fairly well before the end of 1998. This is reflected by a roughly flat RER series.



Note: All the component series are obtained from the IMF International Financial Statistics. All series are first normalized to be 1 in January 1995, and then converted to natural logarithms before being plotted.

Fig. 3.1. Ecuador-U.S. Bilateral Real Exchange Rate and its Components

Things are different between January 1999 and January 2000, the crisis year. While the sucre depreciated about 130%, Ecuadorian inflation was only about 60%. This is reflected in the depreciating trend of the RER series during that year. After dollarization was adopted in January 2000, the exchange rate was fixed, but the Ecuadorian price level continued to rise. By October 2000, Ecuadorian inflation had been enough to eliminate about 50% of the maximum deviation reached by the RER. By April 2003, most of the deviation induced by the currency collapse had been eliminated.

Table 3.1 shows the results of Augmented Dickey-Fuller (ADF) tests for a unit root on the RER series in log terms for both the "stable" pre-crisis period from January 1995 to December 1998, and the full period of analysis which includes the depreciation and appreciation episodes for the RER.

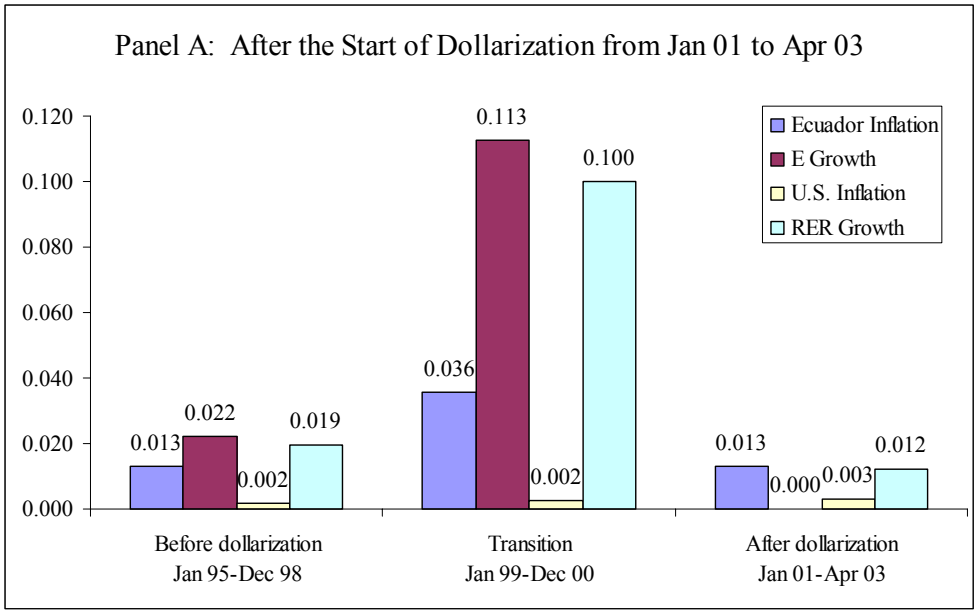
Table 3.1. Augmented Dickey-Fuller Tests for Ecuador's Real Exchange Rate

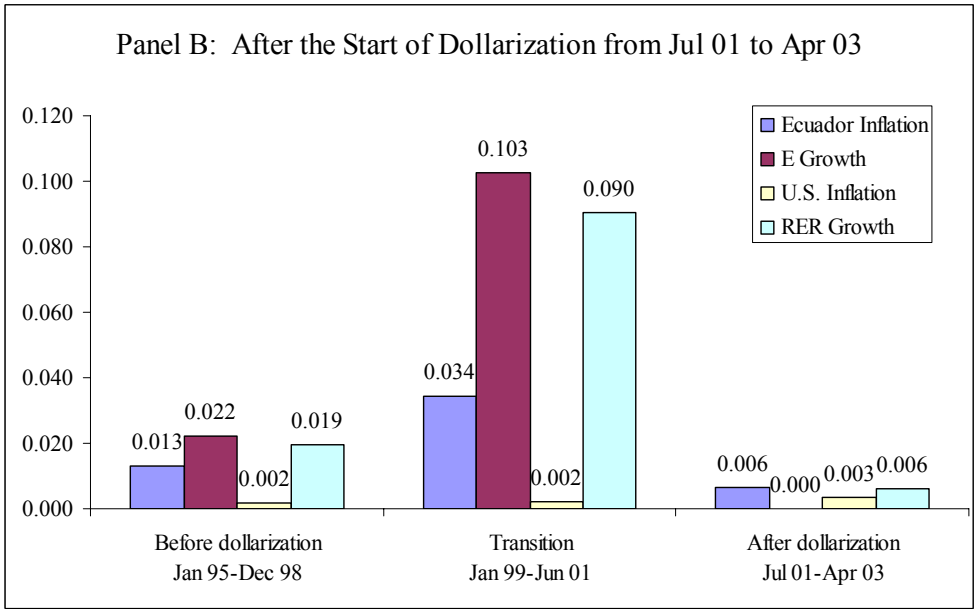
	Jan 95-Dec 98 (N=47) Pre-Crisis Period	Jan 95-Apr 03 (N=99) Full Period
Null Hypothesis: $Ln(RER_t)$ has a unit root.		
Lags:	1	3
ADF t-stat:	-1.977	-1.684
1% level critical t:	-3.581	-3.500
5% level critical t:	-2.927	-2.892
10% level critical t:	-2.601	-2.583
Test Result:	Null not rejected	Null not rejected
Coeff of $Ln(RER_{t-1})$:	-0.232	-0.043
Persistence parameter:	0.768	0.957
Half life of deviations:	2.624 months	15.803 months

Note: All the series are monthly. Persistence is given by the autoregressive coefficient for the $Ln(RER_t)$ series, and is obtained as 1 plus the coefficient of $Ln(RER_{t-1})$. This coefficient is obtained through the ADF test regression, which uses a constant term and the optimal number of lags. The half life of deviations from PPP is calculated as -Ln(2) divided by the Ln of the persistence parameter value.

In both cases, a unit root cannot be rejected. The ADF test t-statistics are -1.98 and -1.68, respectively, and neither is less than the 10% critical value of about -2.60 for both cases. However, the estimated persistence of the RER series is much higher for the full period than for the pre-crisis period: 0.957 versus 0.768, respectively, which correspond to half-lives of PPP deviations of about 15.8 versus 2.6 months, respectively. In addition, it is probable that for the pre-crisis period, the null hypothesis of a unit root could not be rejected only because of low power due to the small number of observations available (N=47 months, versus 99 months for the full period.) That is, the crisis and recovery periods seem to be adding a lot of persistence to the RER.

Finally, the RER and its components also reveal something about immediate benefits obtained with dollarization. Namely, with dollarization, the volatility of the RER series declines, and this happens not only because nominal exchange rate volatility is eliminated but also because domestic price volatility tends to decline. Figure 3.2 shows plots of the volatility of the RER series and its components for the pre-crisis period (January 1995 to December 1998) and two period choices for after the start of dollarization (January 2001 to April 2003, and July 2001 to April 2003.) It is evident from Figure 3.2 how the volatility of the RER series would be exaggerated if the crisis and recovery periods, here denoted as "Transition" periods, were included. It is also evident that a great deal of transitional RER volatility is due to nominal exchange rate volatility. When the periods "Before dollarization" and "After dollarization" are compared, the RER volatility declines mainly because nominal exchange rate volatility has been eliminated. However, when the "After dollarization" periods in panels A and B are compared, it is clear that RER volatility is lower in panel B because the volatility of the Ecuadorian price is lower





Note: Volatility is measured as the standard deviation of the growth series of each variable. Namely, for the real exchange rate (RER), volatility is measured as the standard deviation of the RER growth series; for the CPI of Ecuador, it is measured as the standard deviation of Ecuador's inflation rate series; for the nominal exchange rate (E) it is measured as the standard deviation of the growth of the E series; and for the U.S. CPI it is measured as the standard deviation of the U.S. inflation rate series.

Fig. 3.2. Volatility of the Real Exchange Rate and its Components "Before" and "After" the Start of Dollarization Using Two Alternative "After" Periods

(It has declined from 0.013 to 0.006.) In terms of Engel and Rogers (1996) and Parsley and Wei's (2001) view, it can be said that the "border" between Ecuador and the U.S. has narrowed.[48]

2.2. Descriptive Statistics for the Micro-Real Exchange Rates

Table 3.2 contains descriptive statistics for the 24 $q_{j,t}$ series used in the inter-country analysis in both levels and first differences for the total period, and Figure 3.3 shows the plots of the series in levels using the same scale in all cases. According to Table 3.2, with the exception of soft drinks, all commodities are on average cheaper in Ecuador than in the U.S. during the period of analysis. That is, all commodities, except soft drinks, have a negative mean $q_{j,t}$ level. Bananas are the cheapest commodity with a mean relative price equal to -1.701, which indicates that the dollar price in Ecuador for a pound of bananas is 0.18 times the price in the U.S.[49] Soft drinks are the most expensive commodity with a mean relative price equal to 0.021, indicating that a 2-liter bottle of soft drink costs about 1.02 times more in Ecuador than in the U.S. Finally, the average commodity has a mean relative price of -0.739, indicating that the price level in Ecuador is about one-half the price in the U.S. This admittedly crude estimate with only 23 commodities may not be that inaccurate. Penn World Table data are based on a broader sample of commodities, are annual and only up to the year 2000, but assuming a similar trend as that of the RER, it appears that the mean relative price between Ecuador and the U.S. would be about -0.80.

---

[48] The "Before dollarization" volatility value of 0.019 for the RER shown in Figure 3.2 is more similar to the average volatility value of 0.0163 reported in Table 2 of Engel and Rogers (1996) for cities within Canada than for city pairs within the U.S. (0.0321) or between Canada and the U.S. (0.0367).

[49] According to equation (3.1), $q_{j,t}$ is the log of the common-currency price ratio between Ecuador and the U.S., so to get this ratio we have to calculate the exponential of $q_{j,t}$.

Table 3.2. Descriptive Statistics for the Commodity-Level Relative Price Series

	Level of $q_{j,t}$		First Differences of $q_{j,t}$	
Commodity	Mean	Std	Mean	Std
Rice (white, long grain, uncooked, 1 lb.)	-0.778	0.189	0.0000	0.0727
Spaghetti (and macarroni, 1 lb.)	-0.671	0.318	-0.0068	0.0816
Bread (white, 1 lb.)	-0.486	0.195	-0.0029	0.0610
Beef (for stew, boneless, 1 lb.)	-0.834	0.215	-0.0029	0.0649
Chicken (fresh, whole, 1 lb.)	-0.172	0.208	-0.0029	0.0672
Tuna (light, chunk, 1 lb.)	-0.162	0.106	-0.0017	0.0554
Milk (fresh, whole, fortified, 1 gal.)	-0.476	0.218	-0.0014	0.0722
Eggs (grade A, large, 1 doz.)	-0.148	0.154	-0.0046	0.0936
Bananas (1 lb.)	-1.701	0.299	0.0016	0.0830
Lemons (1 lb.)	-1.292	0.351	-0.0062	0.1857
Apples (red, 1 lb.)	-0.443	0.246	-0.0041	0.0951
Oranges (1 lb.)	-1.618	0.474	0.0005	0.2536
Lettuce (iceberg, 1 lb.)	-1.216	0.301	0.0015	0.2080
Tomatoes (field grown, 1 lb.)	-1.408	0.388	0.0020	0.2301
Beans, dry (dried 1 lb.)	-0.069	0.204	0.0003	0.0650
Potatoes (white, 1 lb.)	-0.883	0.333	-0.0007	0.1240
Sugar (white, 1 lb.)	-0.531	0.137	-0.0024	0.0674
Coffee, ground (100%, 1 lb.)	-1.103	0.228	0.0004	0.0765
Coffee, instant (plain, regular, 1 lb.)	-0.582	0.282	-0.0050	0.0794
Soft drink (non-diet, 2 lit.)	0.021	0.232	-0.0007	0.0764
Wine (red/white table, any origin, 1 lit.)	-1.397	0.221	-0.0007	0.0953
Electricity (1 kwh)	-0.795	0.616	0.0142	0.1226
Gasoline (all types, 1 gal.)	-0.248	0.295	-0.0021	0.0906
Average Commodity Series	-0.739	0.179	-0.0011	0.0560

Note: All series are monthly from January 1995 to April 2003 (N = 100 in levels and 99 in first differences.) The average series is the average of the 23 commodity series. For all commodities, a test for zero mean first difference of $q_{j,t}$ was performed using Newey-West HAC standard errors and covariance; in no case was the mean statistically different from zero. A test, using the same methodology, for zero mean level of $q_{j,t}$ rendered all means statistically negative, except for beans and soft drink. The level of significance used was 5%.

Figure 3.3 reveals that most commodity relative prices follow a pattern reminiscent of the aggregate real exchange rate (See Figure 3.1), exhibiting a dramatic dip that ends around January 2000, the month that dollarization started, and recovering thereafter.

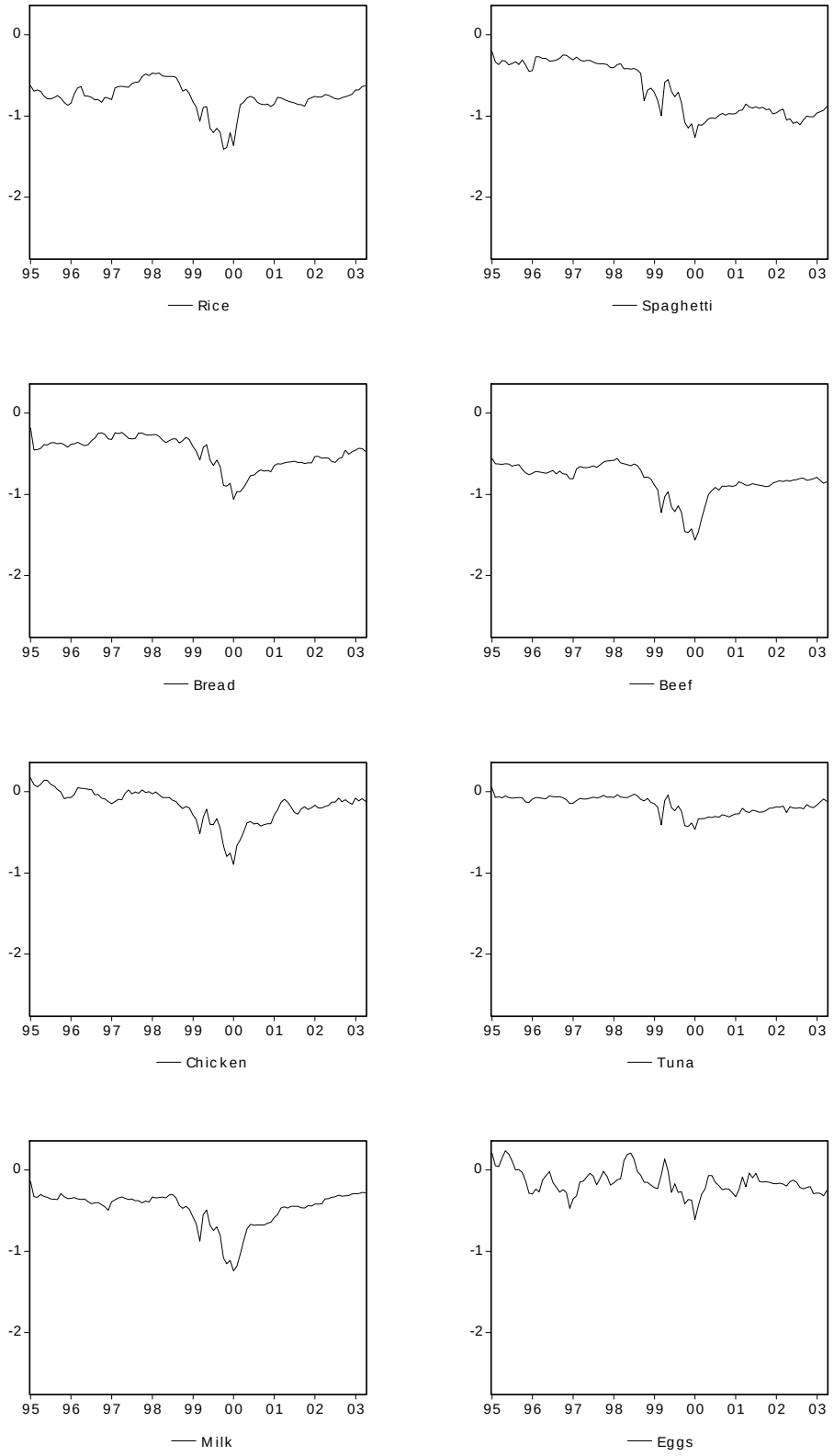
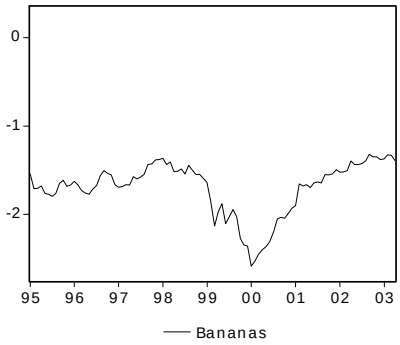
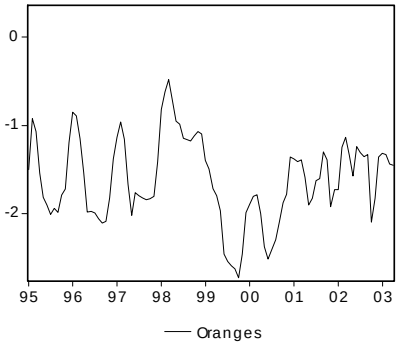
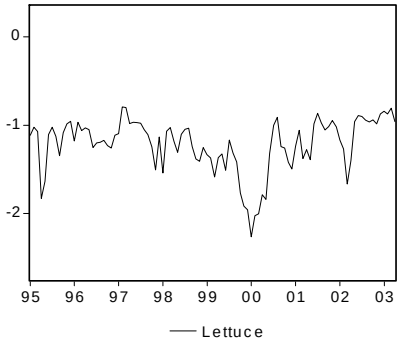
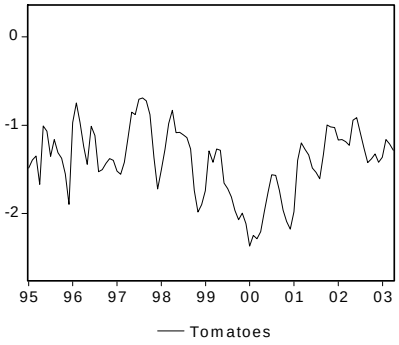


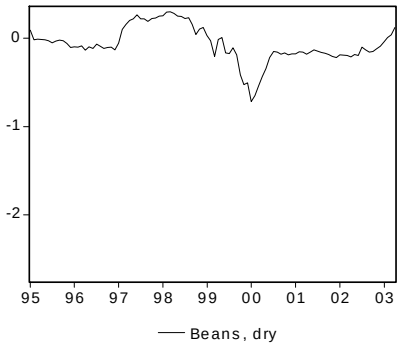
Fig. 3.3. Plots for the Commodity-Level Relative Price Series (Jan 95-Apr 03)











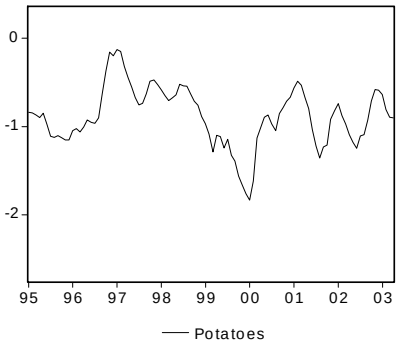
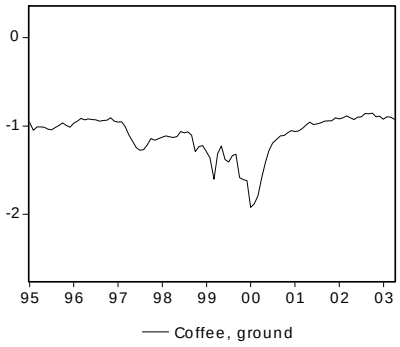
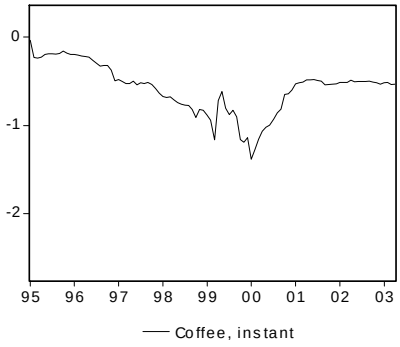
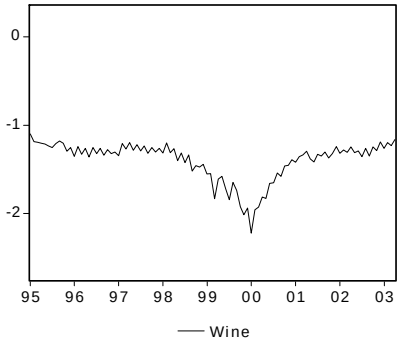
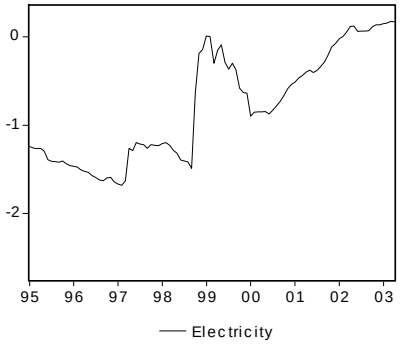


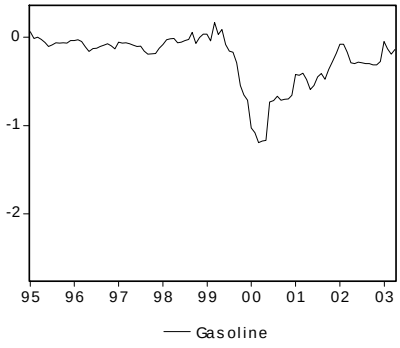
Fig. 3.3. Continued.











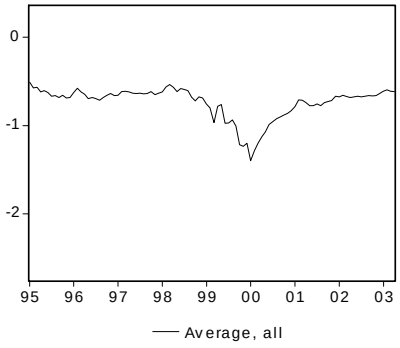


Fig. 3.3. Continued.

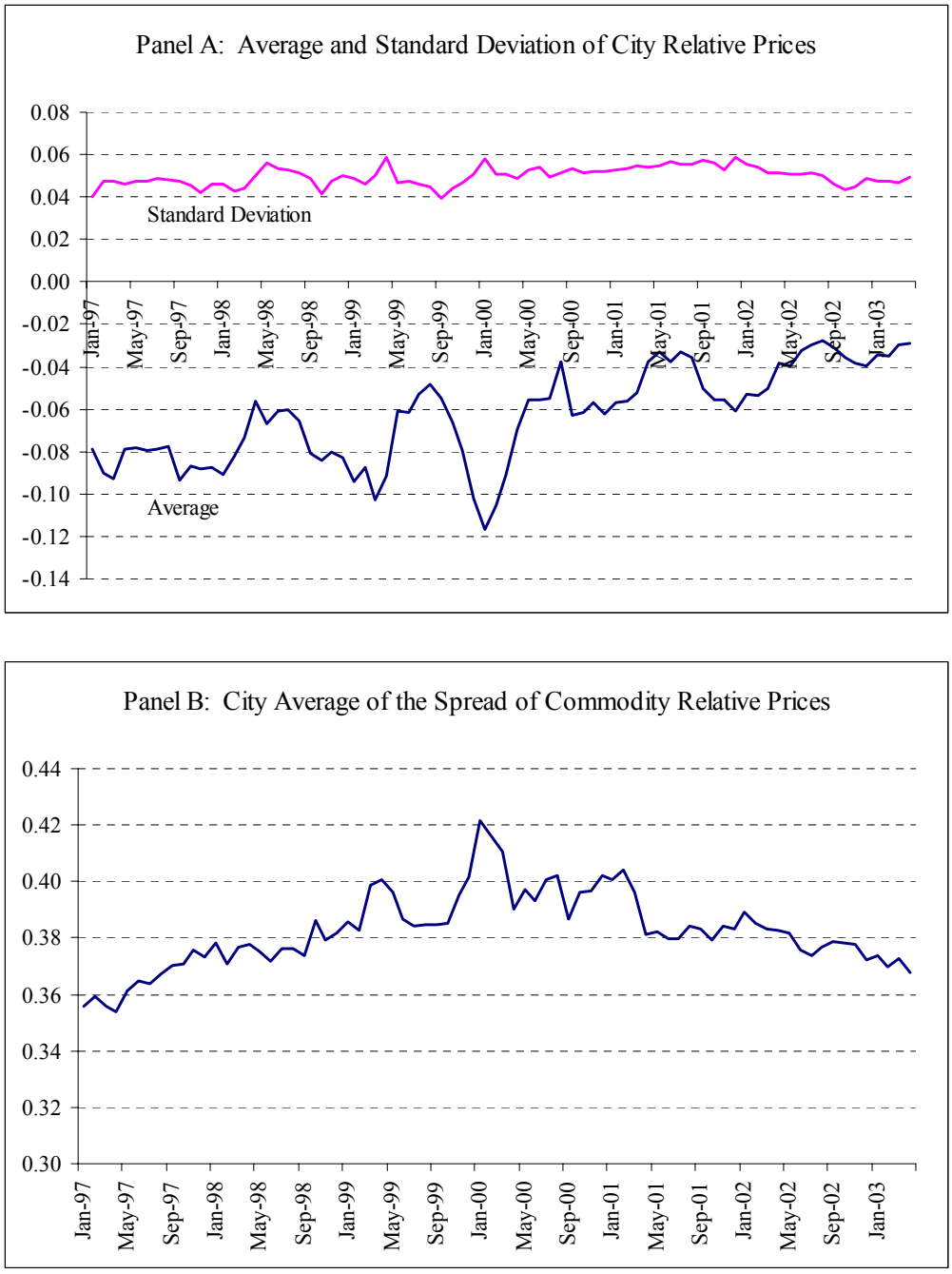
As might be expected, the closest match to this pattern is presented by the average-commodity $q_{j,t}$ series. In fact, regressing the average-commodity series on the RER series in first differences gives a non-significant intercept and a significant slope coefficient equal to 0.997 with an $R^2 = 0.83$. The clearest violation of the RER pattern is shown by the electricity series, which is a regulated price. Some series, such as those for lemons, oranges, lettuce and tomatoes, are so volatile on a monthly frequency that trends and cycle are difficult to detect.[50] However, according to the statistics on first differences shown in Table 3.2, no series has an economically significant trend. Formal tests indicate that, for all commodities, the mean growth rate of the price ratio is not statistically different from zero.

2.3. Descriptive Statistics for the Micro-Relative Prices within Ecuador

The behavior of the relative prices between the Ecuadorian cities and the capital Quito is expected to be different from that of the international relative price measures (e.g. the RER.) Each city's relative price level, $q_{i,t}$, should be fluctuating around a constant mean, and the spread of the commodity relative prices around $q_{i,t}$, which is called $s_{i,t}$, should be roughly constant. In addition, the variance across the relative price levels of the different cities should also be roughly constant. This is unless there has been a change in the relationship between the series.

Panel A of Figure 3.4 shows the average and the standard deviation of the 11 $q_{i,t}$ city series. The behavior of the average line suggests a change over time in the relationship of the price levels of the 11 cities relative to the Quito level. Before the end of 1998, this

[50] For these commodities, the standard deviation of the first differenced $q_{j,t}$ is close to or over 0.2, which is obviously large if compared with the volatility of the average commodity's relative price of just 0.056.



Note: The series in panel A are the simple average and the standard deviation of the relative price level series of the 11 cities other than Quito. The series in panel B is the simple average of the 11 commodity relative price spread series calculated for each city.

Fig. 3.4. Average and Standard Deviation of the City Relative Prices, and City Average Spread Series of Commodity Relative Prices (Jan 97-Apr 03)

average series fluctuates around a mean of -0.08, but after mid 2001 that mean becomes -0.04, a 50% decline. With relative prices being in log terms, the negative sign indicates that, on average, the price level in the cities remains below the Quito level (i.e. the zero line in the graph) all the time, but apparently after the adoption of dollarization it moves closer to the Quito level. It is important to notice that the shift in mean is not immediate but that it takes some months. In addition, the average line displays a dip around the start of dollarization in January 2000, indicating that the switch in regime represented a greater shock for the other cities on average than for Quito, although eventually the cities' prices seem to have recovered faster. With respect to the standard deviation, its line indicates that the relative prices of the cities remained roughly equally spread during the whole period, with the line fluctuating in the band 0.04-0.06. Apparently, although the price levels of Quito and the cities moved closer, some cities' price levels moved away from other cities' price levels at the same time.

Panel B of Figure 3.4, shows the cross-city average of the spread of the commodity relative prices, i.e. the average of the 11 $s_{i,t}$ city series as defined above. According to this plot, the spread of the distribution of the relative prices of the 223 commodities in the cities started around 0.36, became as high as 0.42 around January 2000, and then declined back to around 0.36. The early increase of the spread could be due to internal factors such as disruptions in production caused by El Niño in 1997-1998 and the crisis in 1999. The eventual decline happens while things are slowly returning to normal after the adoption of dollarization. The persistence of the spread trend is ignored in the subsequent analyses in this chapter.

Table 3.3 shows, in part A, estimates of the mean for the relative price series of each city, $q_{i,t}$, before and after the start of dollarization considering no transition months around January 2000, and two alternative transition periods, January 1999 to December 2000 and January 1999 to June 2001. Part B of Table 3.3 shows for each city the average spread, $s_{i,t}$, of the commodity relative price distributions for the same periods. According to Table 3.3, from before, to after the start of dollarization the mean relative price level has moved closer to zero, but the spread of the commodity relative prices has either remained the same or increased slightly; this is for all cities. As expected from Figure 3.4, the price level of the other cities is on average below the Quito level before dollarization. According to Table 3.3, with the exception of Cuenca, all price levels remain below the Quito level after the start of dollarization. The results are only slightly affected by the choice of the transition period.

Comparing the results in Table 3.3 with other research, the estimated mean relative prices of about -0.08 and -0.04 are, in magnitude, similar to the intra-national average log real exchange rates of plus/minus 0.05-0.07 estimated by Parsley and Wei (2001) for Japan and the U.S., and the average spread of commodity relative prices between the cities and Quito of about 0.38 is comparable, although greater than the average measure of price dispersion of 0.28 estimated by Crucini, Telmer, and Zachariadis (2004) across European countries.

3. Trends and Fluctuations in Real Exchange Rates

From the descriptive analysis of section 2 it is evident that the relative price between Ecuador and the U.S. is a highly non-linear stochastic process. This poses challenges in

the assessment of long-run PPP and estimates of the persistence of fluctuations to the relative price, induced, by, for example, abrupt movements in the nominal exchange rate.

Table 3.3. Estimated Mean and Spread of the Commodity-Level Relative Price Before and After the Start of Dollarization for Each Ecuadorian City (Jan 97-Apr 03)

	No Transition Months Excluded			Jan 99 to Dec 00 Excluded			Jan 99 to Jun 01 Excluded		
Part A: Mean of Relative Prices									
City	Before	After	Change	Before	After	Change	Before	After	Change
Ambato	-0.082	-0.058	0.024	-0.083	-0.055	0.028	-0.083	-0.056	0.027
Cuenca	-0.048	0.025	0.073	-0.051	0.033	0.084	-0.051	0.032	0.083
Esmeraldas	-0.059	-0.038	0.021	-0.059	-0.021	0.037	-0.059	-0.014	0.044
Guayaquil	-0.038	-0.025	0.013	-0.043	-0.020	0.023	-0.043	-0.024	0.019
Latacunga	-0.100	-0.084	0.016	-0.100	-0.079	0.022	-0.100	-0.075	0.025
Loja	-0.086	-0.028	0.058	-0.087	-0.016	0.072	-0.087	-0.021	0.066
Machala	-0.057	-0.042	0.015	-0.052	-0.026	0.026	-0.052	-0.021	0.031
Manta	-0.064	-0.026	0.038	-0.062	-0.009	0.053	-0.062	-0.003	0.059
Portoviejo	-0.024	-0.010	0.014	-0.027	-0.008	0.019	-0.027	-0.007	0.019
Quevedo	-0.149	-0.124	0.026	-0.162	-0.122	0.040	-0.162	-0.119	0.043
Riobamba	-0.147	-0.139	0.008	-0.142	-0.134	0.008	-0.142	-0.135	0.008
Average:	-0.078	-0.050	0.028	-0.079	-0.041	0.038	-0.079	-0.040	0.039
Part B: Average Spread of Relative Prices									
City	Before	After	Change	Before	After	Change	Before	After	Change
Ambato	0.318	0.315	-0.003	0.311	0.311	0.000	0.311	0.314	0.003
Cuenca	0.305	0.314	0.009	0.304	0.311	0.006	0.304	0.308	0.004
Esmeraldas	0.376	0.400	0.024	0.370	0.396	0.026	0.370	0.395	0.025
Guayaquil	0.370	0.389	0.019	0.367	0.392	0.025	0.367	0.393	0.025
Latacunga	0.411	0.412	0.001	0.409	0.414	0.005	0.409	0.414	0.006
Loja	0.376	0.386	0.010	0.371	0.380	0.009	0.371	0.373	0.001
Machala	0.403	0.423	0.020	0.392	0.418	0.027	0.392	0.419	0.027
Manta	0.423	0.420	-0.003	0.411	0.404	-0.007	0.411	0.396	-0.015
Portoviejo	0.404	0.414	0.010	0.393	0.401	0.007	0.393	0.395	0.001
Quevedo	0.427	0.424	-0.003	0.428	0.419	-0.009	0.428	0.418	-0.010
Riobamba	0.337	0.363	0.027	0.320	0.348	0.028	0.320	0.343	0.023
Average:	0.377	0.387	0.010	0.371	0.381	0.011	0.371	0.379	0.008
Months:	36	40		24	28		24	22	

Note: The row Average is an average of the city values in the table. The row Months shows the number of months in each period.

For the Ecuador-versus-U.S. analysis, this study follows Papell (2002) who modeled the great swing in the U.S. real exchange rate during the mid-1980s as a break-in-trend event. Ecuador's case seems a natural one for this type of statistical model, not just because of the potential for fitting the data, but because the demarcation of regimes is likely to be exogenous. The onset of the currency collapse was set into motion by external shocks, and the decision to dollarize was at least exogenous to consumers and firms, and largely unexpected in timing.

Accordingly, this episode in Ecuador's exchange rate history can be thought of in terms of three break dates defining four regimes: i) a managed-floating nominal exchange rate regime with a fairly stable real exchange rate; ii) a currency collapse and rapid real depreciation followed by iii) a rapid real appreciation in the early process of dollarization; and iv) a stable inflationary regime under dollarization.

3.1. The Econometric Models

The first type of unit-root test used in this analysis is the typical univariate ADF test, and does not consider any breaks. The test is called "univariate" because it is applied to each relative price series, q_t, independently.[51] The test consists of estimating the following regression:

$$\Delta q_t = \mu + \alpha q_{t-1} + \sum_{k=1}^{p} \beta_k \Delta q_{t-k} + \varepsilon_t \qquad (3.3)$$

where the constant term, μ, is allowed because q_t is required to be constant in steady state but not necessarily to equal zero. That is, relative rather than absolute LOP is required. For this same reason, no trend is allowed in the regression. The Schwarz Criterion (SC) is

[51] The subscript *j* indexing the commodity will be ignored for simplicity of notation.

used to select the optimum number of lags, p.[52] The null and alternative hypotheses for this test are Ho: $\alpha = 0$, and Ha: $\alpha < 0$, with the null hypothesis indicating the presence of a unit root. Under Ho, the t-statistic for α does not follow the typical t-student distribution, so the critical values have to be calculated independently. Most statistical programs already provide MacKinnon (1996) critical values.

The second type of unit-root test used is still univariate but incorporates a mechanism to control for the regime changes. As indicated above, the demarcation of regimes is likely to be exogenous to the data generating process of the relative price series. Following Papell (2002), each q_t series is allowed to have three breaks intended to control for the four hypothesized regimes. Once the break dates, i.e. months $TB1$, $TB2$ and $TB3$, are defined, each one of the 24 q_t series is de-trended using the following regression:

$$q_t = \mu + \gamma_1 DT1_t + \gamma_2 DT2_t + \gamma_3 DT3_t + z_t \tag{3.4}$$

with the γ coefficients subject to the following two restrictions:

$$\gamma_1 + \gamma_2 + \gamma_3 = 0 \tag{3.5}$$

$$\gamma_1 (TB3 - TB1) + \gamma_2 (TB3 - TB2) = 0 \tag{3.6}$$

where $DTi_t = (t - TBi)$ if $t > TBi$, and zero otherwise, for $i = 1, 2, 3$. Restrictions (3.5) and (3.6) make sure the resulting trend has the desired shape, i.e. with the same constant mean before $TB1$ and after $TB3$, and a triangular shape in between with the apex at $TB2$ (The break dates and the implied regimes are defined in the next section.) Each de-trended series consists of the residuals z_t of equation (3.4). After obtaining the 24 residual series, the following regression is estimated:

[52] p is the number of lags, between 1 and 12, that produces the lowest SC for equation (3.3).

$$\Delta z_t = \alpha z_{t-1} + \sum_{k=1}^{p} \beta_k \Delta z_{t-k} + \varepsilon_t \qquad (3.7)$$

to test Ho: $\alpha = 0$ versus Ha: $\alpha < 0$, where Ho implies that the q_t series has a unit root without breaks, and Ha implies that the q_t series is stationary with breaks that are consistent with mean reversion. Under Ho, the t-statistic for α does not follow the typical t-student distribution, and because of the particular kind of trend assumed in equation (3.4), the critical values are not readily available from statistical packages.

The critical values for the univariate unit-root test with breaks are obtained through Monte Carlo simulation. The simulation consists of 50,000 iterations, each time generating a unit-root series of length 100, which is the number of months in the sample.[53] The unit-root series is then de-trended using equation (3.4) subject to restrictions (3.5) and (3.6), and its residuals are regressed according to equation (3.7) to obtain the t-statistic of coefficient α. Using this procedure, a total of 50,000 t-statistic values are obtained. These values are sorted in ascending order, and the 500th, 2,500th, and 5,000th values are selected as the critical t values at the 1%, 5% and 10% significance level, respectively. These values are -3.516, -2.876, and -2.552, respectively.

The third type of unit-root test for this analysis is the Maddala and Wu (1999) test, which consists of combining the results of individual univariate unit root tests to increase statistical power. Univariate tests could fail to reject the null hypothesis of a unit root because of low statistical power. The solution, according to recent literature, is to use tests that exploit the structure provided in panel data, when available. Two usual unit-root tests for panel data are the Levin, Lin, and Chu (2002) and the Im, Pesaran, and Shin

[53] Actually, 200 random-walk observations were generated with zero as initial value, and only the last 100 were used.

(2003) tests. However, although these tests could be applied to the series without controlling for structural breaks, they would not be appropriate for the series once de-trended to control for the breaks. The reason is that the trend assumed by equations (3.4), (3.5), and (3.6) is not typical, and so these tests applied to the de-trended series would produce the wrong critical values. The Maddala-Wu test is appropriate in both situations.[54]

The Maddala-Wu test consists of first obtaining the p-values for the t-statistics of the coefficients α estimated with the univariate unit-root tests for the individual commodity relative price series. For the de-trended series, the p-values are obtained using the list of sorted t-statistic values generated with the Monte-Carlo simulation explained above. For the series without breaks, a new Monte-Carlo simulation is needed, this time excluding the step where the unit-root series are de-trended. According to Maddala and Wu (1999), these p-values follow a Uniform distribution between 0 and 1, and -2*Ln*(*p-value*) follows a χ^2 distribution with 2 degrees of freedom. Because of the additive property of the χ^2 distribution, the p-values for the individual univariate tests can be combined so that the statistic:

$$\lambda = -2\sum_{j=1}^{N} Ln(p\text{–}value_j) \qquad (3.8)$$

has a χ^2 distribution with 2*N* degrees of freedom. The null and alternative hypotheses of this test are Ho: $\alpha_j = 0$ for all *j*, and Ha: $\alpha_j < 0$ for some *j*, respectively, where $j = 1, 2, \ldots,$ N. Because in this test, the p-values are obtained from individual ADF tests on the commodity relative price series, the series are not assumed to follow the same

[54] The Maddala-Wu test is based on an approach proposed by Fisher (1932). A similar concept is also presented in Choi (2001).

autoregressive process. That is, the α_j coefficients are allowed to vary across the series. Ho, which implies that all series have a unit root, is rejected if the test statistic λ is greater than the appropriate χ^2 critical value.[55]

The Maddala-Wu test is not applied to the entire set of 23 commodity relative price series.[56] If the series are heterogeneous, some of them could drive the result of the test. According to the standard deviation values shown for the first-differenced series in Table 3.2 of section 2.2, a few commodities are much more volatile than the rest. In addition, some series could be subject to particular influences in a way that the trend described by equations (3.4), (3.5) and (3.6) does not apply to well. The test is, thus, applied to a sub-set of selected commodities. The selection consists of calculating the standard deviation of the de-trended series, determining the 75th percentile of the standard-deviation distribution, and eliminating those series with standard deviation above this percentile.[57] The commodities excluded using this criterion are electricity, oranges, lemons, potatoes, tomatoes and spaghetti, leaving 17 commodities for the test.

3.2. The Three Structural Break Dates

To simplify the analysis, the break dates *TB*1, *TB*2 and *TB*3 are chosen exogenously and assumed to be the same for all relative price series.[58]

*TB*1 is chosen to be January 1999. This month marks both the end of the pre-crisis regime, with a stable real exchange rate, and the beginning of the crisis. It is one month

[55] For simplicity, any contemporaneous cross-correlations of the series are ignored. Under cross-correlated errors, the individual tests on the series are not independent, and hence λ does not follow a χ^2 distribution.
[56] The series for the average commodity is obviously excluded.
[57] Papell (2002) uses a different measure of fit to the hypothesized pattern, but he uses a 0.75 cutoff value, too. Papell also uses a different panel test.
[58] The selection of the break dates could be made "endogenous," i.e. determined by the data themselves, and for each series independently. Papell (2002) does multiple structural break determination using Bai's (1999) method. For the purpose of this paper, exogenous common breaks are enough.

after the failure of the largest bank in Ecuador (after others had failed during 1998), and one month before the government had to let the exchange rate float freely. During this month more banks failed, despite the existence of a newly installed deposit insurance agency. After this month, the financial and currency crisis fully developed, causing the relative prices between Ecuador and the U.S. to fall into severe depreciating mode.

*TB*2 is chosen to be January 2000, the month dollarization was adopted. This month marks the end of the currency crisis and relative price depreciation, and the beginning of the relative price recovery. This is clearly appreciated in Figure 3.1 for the RER and Figure 3.3 for most commodity relative prices, particularly for the average commodity. During this transition period, the RER rapidly appreciated, with a tendency to return to the pre-crisis levels. This recovery of relative prices is assumed to end in month *TB*3.

*TB*3 is chosen to be June 2001. This month marks the end of the relative price recovery period, and the beginning of a period where prices are assumed to be back in equilibrium at the same level as that of the pre-crisis period. The choice of *TB*3 implies a trade-off between time allowed for prices to recover and time for the new equilibrium period to be long enough to be consistent with mean reversion of the relative prices. *TB*3 is chosen to be a year and a half after the start of dollarization because by then a great deal of aggregate price recovery had already occurred. Inflation in 2000 was 91%, higher than during the three previous years (30.7%, 43.4% and 60.7% in 1997, 1998 and 1999, respectively), and in 2001 inflation was just 22.4%, already below the levels of the years before 1998.[59]

[59] In addition, June 2001 is close to March 2001, which is the month that gives the best fit for the relative price series of the average commodity under the hypothesized trend breaks. Using March 2001 as *TB*3 does not change the results significantly.

3.3. Results of the Unit Root Tests With and Without Breaks

Table 3.4 presents the results of the univariate and the Maddala-Wu unit-root tests with and without structural breaks. For comparison, Table 3.4 also includes the results of the univariate tests applied to the CPI-based RER.

According to the univariate tests results, controlling for the breaks renders more relative price series as stationary. When the breaks are not considered, the null hypothesis of a unit root is rejected only for 6 of the 24 commodity series at better than 10% significance level.[60] Even for the average commodity series, a unit root cannot be rejected. On the other hand, when the breaks are controlled for, a unit root can be rejected for 16 of the 24 commodities. This time, the unit root hypothesis is rejected for the average commodity series at the 1% significance level. In addition, for the six commodity series that were found stationary without the breaks, the level of significance of the rejection of a unit root increases when the breaks are used. That is, for these series, the breaks are not necessary but nevertheless help. Figure 3.3 shows that all these six series present a dip in value around January 2000, but that dip is disguised by the variability of the series.

The eight commodity relative price series for which the univariate tests with breaks fail to reject the null hypothesis of a unit root have something in common. According to Figure 3.3, they fail to follow the assumed trend described by equations (3.4), (3.5) and (3.6) at some degree. The worst case is electricity with an apparent broken upward trend. The trend, however, can be explained because electricity is a utility with prices set by the government. The next case is spaghetti, whose relative price apparently never recovered after the crisis. In fact, the relative price for spaghetti initially suffered a fall in October

[60] A 10% level of significance level is used because of the alleged low power of the univariate tests.

Table 3.4. Results of Univariate and Maddala-Wu Unit-Root Tests Without and With Structural Breaks

Part A: Univariate Tests

	Tests Without Breaks			Tests With Breaks		
Commodity	Lags	t-stat	Half Life	Lags	t-stat	Half Life
Rice	3	-2.46	6.9	3	-3.24 **	3.7
Spaghetti	1	-1.30	20.1	2	-0.88	25.6
Bread	1	-1.43	16.3	2	-1.49	9.9
Beef	3	-2.10	10.7	3	-2.61 *	4.7
Chicken	1	-1.99	10.3	1	-3.44 **	3.1
Tuna	2	-1.72	7.6	2	-2.55	3.1
Milk	1	-1.80	11.5	1	-4.34 ***	1.8
Eggs	1	-3.59 ***	2.8	1	-3.87 ***	2.3
Bananas	1	-1.35	18.1	1	-3.01 **	3.5
Lemons	2	-3.54 ***	3.3	3	-4.95 ***	1.7
Apples	1	-2.74 *	6.2	1	-3.51 **	3.7
Oranges	1	-4.27 ***	3.0	1	-5.43 ***	1.9
Lettuce	2	-3.14 **	2.5	3	-4.34 ***	1.1
Tomatoes	6	-1.58	6.7	6	-3.58 ***	1.0
Beans, dry	1	-1.74	12.2	1	-2.10	7.8
Potatoes	1	-3.28 **	6.2	1	-3.69 ***	4.8
Sugar	2	-2.42	5.5	2	-3.06 **	3.0
Coffee, ground	1	-1.82	10.9	1	-2.68 *	4.7
Coffee, instant	1	-1.66	14.5	2	-1.81	9.4
Soft drink	1	-1.63	12.2	2	-2.09	5.0
Wine	4	-1.92	9.8	4	-2.65 *	3.0
Electricity	1	-0.93	36.7	1	-0.99	33.5
Gasoline	1	-1.79	12.2	1	-2.49	5.6
Average Commodity	3	-1.75	12.1	1	-4.44 ***	1.5
RER	3	-1.68	15.8	2	-2.10	4.8

Part B: Maddala-Wu Tests on Group of 17 Selected Commodities

Null Hypothesis: All relative-price series have a unit root.

λ test stat:	52.21	111.99
df:	34	34
1% critical χ^2:	56.06	56.06
5% critical χ^2:	48.60	48.60
10% critical χ^2:	44.90	44.90
Test Result:	Null rejected at 5%	Null rejected at 1%

Note: (*)(**)(***) One, two and three askerisks indicate rejection of the null of a unit root at 10%, 5%, and 1% significance, respectively, for the univariate tests. All series are monthly from January 1995 to April 2003 (N=100). The average series is the average of the 23 commodity series. For the tests without breaks, the test regression includes a constant, and the MacKinnon t critical values are -3.50, -2.89 and -2.58 at 1%, 5% and 10% significance, respectively. For the tests with breaks, the test regression does not include a constant and the t critical values, found through Monte Carlo simulations, are -3.52, -2.88 and -2.55 at 1%, 5% and 10% significance, respectively. All tests use optimal number of lags selected through the Schwartz Criterion between 1 and 12 lags. RER is the CPI-based Real Exchange Rate series between Ecuador and the U.S. Half life = -Ln(2)/Ln(persistence), where persistence is the estimated autoregressive coefficient obtained through the ADF test regressions.

1998, when the INEC changed the units for the prices collected. Without more information, it can be suspected that the change in units may have been accompanied by a change in other characteristics of the product that were not reflected as adjustments in the price series. For bread, tuna and gasoline, the relative price series seems to still be in an adjusting mode by the end of the period of analysis, so that mean reversion is never completed. The beans series has an unexplained hump right before the crisis, but otherwise seems to follow the assumed trend. Finally, the series for instant coffee and soft drinks seem not to not satisfy the requirement of being roughly flat during the pre-crisis period.

Table 3.4 also shows that when the structural breaks are not considered, the persistence of relative price deviations from conditional LOP are exaggerated. With the exception of spaghetti, the half-life of deviations for all the series is longer when the breaks are ignored – sometimes much longer. Focusing on the average commodity, without controlling for the breaks the half-life of deviations is 12.1 months, but with the breaks it reduces to only 1.5 months. Even for the RER, which is found to be non-stationary either with or without the breaks, the half-life of deviations is reduced from 15.8 to 4.8 months with the help of the assumed breaks.

From the Maddala-Wu test results in Table 3.4, it is evident that the use of the breaks is not crucial for the series to be found stationary as a group, but it still helps. Without the breaks, the Maddala-Wu null hypothesis is rejected at a 5% significance level, but with the breaks the rejection occurs at better than 1%. The former result is due to the relatively fast speed of recovery from deviations of the individual series even without the use of the breaks. According to the results of the tests without breaks shown in Table 3.4, with the

exception of electricity, all the series have a half-life of deviations that is much shorter than the literature consensus of three to five years. What needs to be considered, nonetheless, is that it was the adoption of dollarization on January 2000 that put an end to the depreciating trend of relative prices. It is probable that this episode would have been much more persistent if dollarization had not been adopted.[61]

4. Price Integration in Ecuador under Dollarization

The intra-national analysis examines the question of whether the adoption of dollarization in January 2000 has been accompanied by an increase in the degree of price integration between 11 Ecuadorian cities and Ecuador's capital city, Quito. The choice of Quito as the numeraire city is based on the fact that it has traditionally been regarded as the most expensive and well off city in the country.[62] Increased integration with Quito in terms of price levels could imply integration in other aspects and an improvement in economic conditions. After all, wages tend to move with price levels.

4.1. Inter-City Price Gap Reductions

The hypothesized reduction in price-level gaps between the other cities and Quito presupposes the existence of persistent price differences, the nature of which would have changed with the start of dollarization. Despite Ecuador's size, there are structural differences across the cities that justify price differences. In a Kravis and Lipsey (1983),

[61] In section 2, another role of dollarization was mentioned: the reduction of RER volatility not only by eliminating nominal exchange rate volatility but also by reducing actual price volatility. This extra role of dollarization also applies to the relative price for the average commodity as a proxy for the RER.
[62] Quito, Guayaquil and Cuenca are the cities with the highest median wages. According to Larrea (2004), during 2002, the Quito median wage was on average 2.01 times that in Guayaquil and 1.13 times that in Cuenca.

Bhagwati (1984), and Balassa (1964, 1973) and Samuelson (1964) fashion, prices would tend to be higher where incomes are higher. In addition, some commodities are produced in certain cities but not in others. There are also transaction and transportation costs which make some commodities more tradable than others. There may also be productivity differentials across cities, and even monopolistic behavior of retailers as suggested by Engel and Rogers (1996) and O'Connell and Wei (2002).

Price gap reductions between the cities and Quito could happen because of asymmetric responses to the new regime. According to Beckerman (2002), by 1999 Ecuador was highly informally dollarized; the proportion of dollar denominated bank deposits and loans was over 50%. It can be assumed that Quito, being the capital and a main economic center, was relatively better prepared for the switch in currency than the other cities. In fact, the dip on the average city relative price in January 2000 shown in Figure 3.4 indicates that the shock of the switch was, on average, greater for the other cities. After the adoption of dollarization, the other cities must have incurred more expenses to adapt to the new system, reflecting this as increases in prices over those incurred in Quito. The degree of adaptation achieved could have well depended on the cities' availability of resources, and other initial conditions. The pass-through to prices could depend on the degree of market power of producers across cities, and the flexibility that they have to set prices.

4.2. Price Integration Analysis

The analysis assumes that Quito and the other cities were initially sharing the same inflation rate. Then, after a transition period around the start of dollarization during which

inflation rates are allowed to diverge, the other cities and Quito return to a new steady state under dollarization, again sharing the same inflation rate. The initial and final inflation rates need not be the same.[63] This process implies that there may have been a statistically significant shift in the mean relative prices of the cities with respect to Quito after the adoption of dollarization. In addition, the spread of the commodity relative prices could have changed.

The main result for this analysis is obtained using a pre-post t test. According to section 2, for each city the relative prices of commodities would be distributed around a city-specific mean, $q_{i,t}$, with standard deviation $s_{i,t}$. This approach consists of testing for a change in the average levels of $q_{i,t}$ and $s_{i,t}$ from before to after the start of dollarization. Taking into account that the series may have been more volatile around the time dollarization was adopted, the test considers a transition period. The "Before" dollarization period is chosen to be from January 1997 to December 1998, and the "After" the start of dollarization period from July 2001 to April 2003. The test is a "matched-samples" test to control for city-specific fixed effects. As a robustness check, the non-parametric Wilcoxon Signed Rank test is also used.

The next step is to analyze the implications of the results for convergence in relative prices, if any, across the cities. For absolute convergence, there should be a negative relationship between the change in the relative price level after dollarization and its level before dollarization. The approach is borrowed from the income convergence literature[64], and consists of estimating the following regression:

$$\Delta q_i = \alpha + \beta q_{i,Before} + \varepsilon_i \qquad (3.9)$$

[63] In fact, average annual inflation for 1997-1998 is over 30%, while for 2002-2003 is only around 8%.
[64] See Barro and Sala-i-Martin (1992, 1995) and Mankiw, Romer, and Weil (1992). For a thorough review of these and other related literature see McCallum (1996b).

where $q_{i,Before}$ is the average $q_{i,t}$ for the "Before" period, and Δq_i is the difference between $q_{i,After}$ and $q_{i,Before}$, where $q_{i,After}$ is the average $q_{i,t}$ for the "After" period, all for city i. Under absolute convergence, coefficient α is common for all cities and depends on parameters of the process of convergence, particularly on the new steady state. Coefficient β is expected to be negative and statistically significant. It has to be noted that, because there are only 11 cities other than Quito, the tests will likely have low statistical power. Convergence is also analyzed within each city for the commodity prices. For that purpose, equation (3.9) is estimated for each city separately replacing the city subscript i with the subscript j for the commodity, with $j = 1, 2, \ldots, 223$.

The final step of the analysis consists of some robustness checks. The first is a variation of the pre-post test to include time variability in the estimations. For that, the following regressions are estimated for each city, i, individually:

$$q_{i,t} = \alpha_{0i} + \alpha_{1i} D_{i,t} + \varepsilon_{i,t} \tag{3.10}$$

$$s_{i,t} = \beta_{0i} + \beta_{1i} D_{i,t} + \upsilon_{i,t} \tag{3.11}$$

where $D_{i,t}$ is a dummy variable that takes on the value 1 for t ≥ January 2000, and zero otherwise. The intercepts capture the average level of the series before dollarization, and the coefficients of the dummy variable capture any change in this mean after the start of dollarization. Coefficient tests use Newey-West HAC standard errors and covariances to account for possible heteroscedasticity and autocorrelation of unknown form in the error terms.[65] For the time series analysis, the full period from January 1997 to April 2003 is used.

[65] See Newey and West (1987).

The time series analysis can be extended by using an approximation to equation (3.10) under the assumption that the relative price, $q_{i,t}$ follows a first-order autoregressive process with a break in mean. For this, the following equation is estimated for each city *i* individually:

$$q_{i,t} = \alpha_{0i} + \alpha_{1i} D_{i,t} + \rho_i q_{i,t-1} + \varepsilon_{i,t} \tag{3.12}$$

where coefficient ρ_i gives the persistence of the process, and the intercept and the coefficient of the dollarization dummy can be used to calculate the means of the relative-price series process before and after the start of dollarization as $\alpha_{0i}/(1-\rho_i)$ and $(\alpha_{0i} + \alpha_{1i})/(1-\rho_i)$, respectively, for each city *i*. Still, a statistically significant dummy variable coefficient would indicate a shift in mean after the start of dollarization. An advantage of this method is that the estimation of the before and after mean relative-price levels can be done without the prices actually reaching the steady states. Another advantage is that it allows an estimation of persistence. A disadvantage is that the parametric assumption for the time series may be too restrictive.

The last robustness check consists of a panel-regression analysis in an effort to use at simultaneously both the time and cross-section variability in the relative price data. Two different specifications are used, each estimated for each city *i* individually as a panel of 223 commodity relative price series in length of 76 months (January 1997 to April 2003.) The first model is the panel version of equation (3.10):

$$q_{i,j,t} = \alpha_{0i,j} + \alpha_{1i} D_{i,j,t} + \varepsilon_{i,j,t} \tag{3.13}$$

which is estimated ignoring any serial correlation in the series, and assuming common dummy coefficients but different intercepts across commodities. The second specification is the panel version of equation (3.12), estimated under the same assumptions of equation

(3.13) plus the assumption that the autoregressive coefficient is common across commodities:

$$q_{i,j,t} = \alpha_{0i,j} + \alpha_{1i} D_{i,j,t} + \rho_i q_{i,j,t-1} + \varepsilon_{i,j,t} \quad (3.14)$$

Because of the presence of the lagged dependent variable as a regressor, equation (3.14) has to be estimated as a dynamic panel.

4.3. Price Integration Analysis Results

Table 3.5 shows the results for the pre-post matched-sample tests for a change in the mean city relative price level, and the spread of the distribution of relative prices of commodities from "Before" to "After" the start of dollarization. Table 3.5 also shows the results for non-tradable and tradable commodities separately.[66] On the average, the results for both types of commodities and the combined result indicate that relative prices are on average negative before and after the start of dollarization, but after dollarization they are closer to zero, and the size of the increase is statistically significant. The "All Commodities" columns indicate that the mean city relative-price level was initially -0.079 and became -0.040 after dollarization. The positive shift of 0.039 is significant according to both the t test (p-value = 0.000) and the Wilcoxon test (p-value = 0.036.) Keeping on the same columns, the city values follow more or less the same pattern. This is despite some cities' exhibiting some divergence with respect to the relative price of non-tradables or tradables.[67] The significance of the result for the shift in mean relative price is weaker for non-tradables and basically the same for tradables.

[66] According to the INEC, non-tradable commodities are services, rent, transportation, education and utilities, while tradable commodities are agricultural, manufactured, and very-easy-to-transport products.

[67] For example, the relative price has moved away from zero rather than closer to it for Guayaquil, Latacunga and Riobamba for non-tradables, and for Cuenca, Manta and Portoviejo for tradables.

Table 3.5. Pre-Post Matched-Sample Tests For Mean Relative Prices and Spread of Commodity- Level Relative Prices for 11 Ecuadorian Cities By Type of Commodity

Part A: Average-Commodity Relative Price Level

	All Commodities (N=223)			Non-Tradable Only (N=35)			Tradable Only (N=188)		
City	Before	After	Diff	Before	After	Diff	Before	After	Diff
Ambato	-0.083	-0.056	0.027	-0.258	-0.194	0.064	-0.051	-0.030	0.020
Cuenca	-0.051	0.032	0.083	-0.154	0.026	0.180	-0.032	0.033	0.065
Esmeraldas	-0.059	-0.014	0.044	-0.195	-0.191	0.004	-0.033	0.018	0.052
Guayaquil	-0.043	-0.024	0.019	-0.054	-0.081	-0.027	-0.041	-0.014	0.027
Latacunga	-0.100	-0.075	0.025	-0.367	-0.382	-0.015	-0.051	-0.018	0.033
Loja	-0.087	-0.021	0.066	-0.320	-0.185	0.135	-0.044	0.009	0.053
Machala	-0.052	-0.021	0.031	-0.201	-0.125	0.077	-0.024	-0.002	0.022
Manta	-0.062	-0.003	0.059	-0.281	-0.205	0.076	-0.021	0.035	0.056
Portoviejo	-0.027	-0.007	0.019	-0.211	-0.209	0.001	0.008	0.030	0.023
Quevedo	-0.162	-0.119	0.043	-0.435	-0.344	0.091	-0.111	-0.077	0.034
Riobamba	-0.142	-0.135	0.008	-0.351	-0.374	-0.024	-0.104	-0.090	0.013
City Average	-0.079	-0.040	0.039	-0.257	-0.206	0.051	-0.046	-0.010	0.036
Matched-sample t test									
t stat:			5.552			2.464			6.924
p-value:			0.000			0.033			0.000
Wilcoxon sum rank rest									
Value:			2.101			1.051			2.364
p-value:			0.036			0.293			0.018

Part B: Spread of Commodity Relative Prices

	All Commodities (N=223)			Non-Tradable Only (N=35)			Tradable Only (N=188)		
City	Before	After	Diff	Before	After	Diff	Before	After	Diff
Ambato	0.311	0.314	0.003	0.379	0.323	-0.056	0.286	0.306	0.020
Cuenca	0.304	0.308	0.004	0.375	0.266	-0.108	0.286	0.315	0.029
Esmeraldas	0.370	0.395	0.025	0.522	0.539	0.017	0.329	0.353	0.024
Guayaquil	0.367	0.393	0.025	0.574	0.574	0.001	0.316	0.350	0.033
Latacunga	0.409	0.414	0.006	0.759	0.739	-0.019	0.279	0.289	0.010
Loja	0.371	0.373	0.001	0.499	0.505	0.005	0.326	0.335	0.010
Machala	0.392	0.419	0.027	0.507	0.501	-0.007	0.360	0.400	0.040
Manta	0.411	0.396	-0.015	0.497	0.419	-0.078	0.380	0.381	0.001
Portoviejo	0.393	0.395	0.001	0.567	0.553	-0.014	0.342	0.346	0.004
Quevedo	0.428	0.418	-0.010	0.686	0.595	-0.092	0.337	0.363	0.026
Riobamba	0.320	0.343	0.023	0.437	0.418	-0.018	0.278	0.308	0.031
City Average	0.371	0.379	0.008	0.527	0.494	-0.034	0.320	0.341	0.021
Matched-sample t test									
t -stat:			1.858			-2.614			5.381
p-value:			0.093			0.026			0.000
Wilcoxon sum rank rest									
Value:			0.788			0.263			1.379
p-value:			0.431			0.793			0.168

Note: The Before and After values are time averages for the periods Jan 97-Dec 98 and Jul 01-Apr 03, respectively. The months from Jan 99 to Jun 01 are considered transitional. The City Average row is a simple average of the city values. The null hypothesis for the matched-sample t test is that the Before and After means are the same. The Wilcoxon test is non-parametric and tests for a change in the median.

With respect to the spread of the relative price of commodities, Table 3.5 indicates that non-tradables show a decrease while tradables show an increase with the net effect being an increase. However, while the t tests indicate that the change in spread is statistically significant, the non-parametric Wilcoxon tests show the opposite. In any case, the changes in spread appear small relative to the mean spread values (For the "All Commodities" case, the change of 0.008 is just about 2% of the initial value 0.371.)

It is worthwhile mentioning that Table 3.5 shows that non-tradable commodities are on average much cheaper in the 11 cities relative to Quito than tradable commodities. The mean relative prices of non-tradables both before and after dollarization (-0.257 and -0.206) are much lower than those of tradables (-0.046 and -0.010.) In addition, the relative prices of non-tradable commodities are much more disperse than those of tradable commodities (Compare 0.527 with 0.320 for the "Before" city-average spread.) The latter result is consistent with the literature on price dispersion across locations (See for example Crucini et al., 2004.)

Table 3.6 presents the results on relative price convergence. According to the cross-city results, there is no absolute convergence between the 11 cities and Quito. The β coefficient (0.083) is positive and non-significant, instead of negative. That is, at the city level, there is no relationship between the relative price level before dollarization and the change in that price afterwards. This result is consistent with a non-decreasing standard deviation of city relative prices shown in Figure 3.4. Obviously, the price changes are strongly dominated by particularities of each city.[68]

[68] Another consideration is that with the small N=11 cities, statistical power is obviously small, and so meaningful relationships cannot be accurately detected.

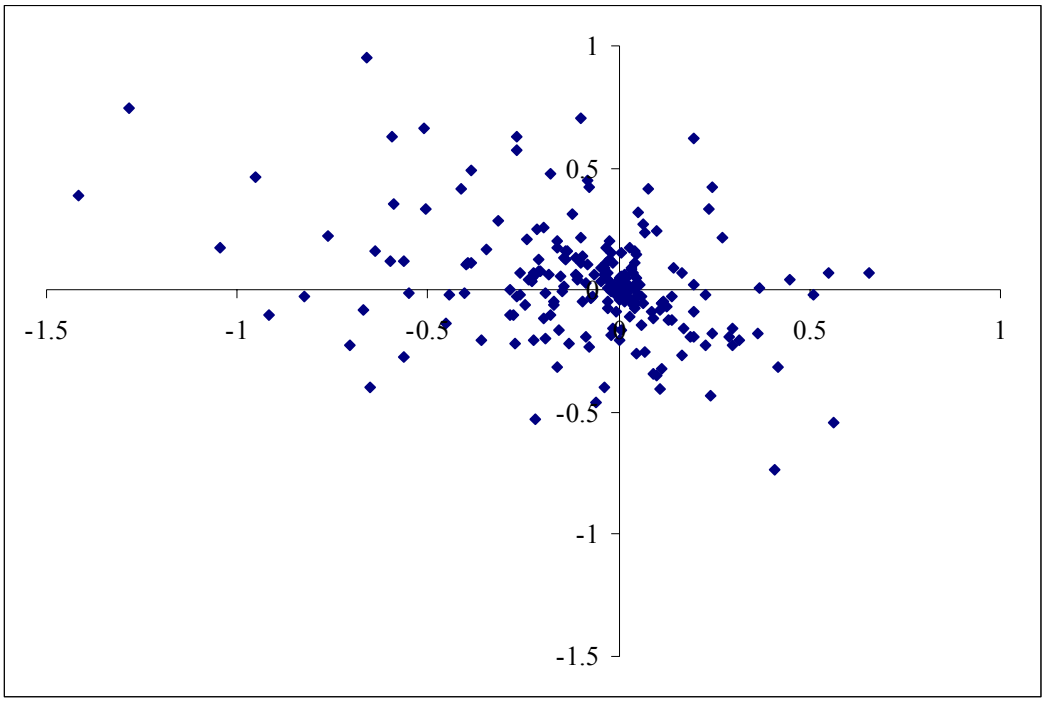
Table 3.6. Change in Relative Price Regressed on Initial Relative Price Level

City	N	α	β	R^2
Cross-City	11	0.045 **	0.083	0.02
		(0.016)	(0.181)	
Ambato	223	0.004	-0.282 ***	0.13
		(0.015)	(0.050)	
Cuenca	223	0.065 ***	-0.357 ***	0.16
		(0.016)	(0.055)	
Esmeraldas	223	0.033 *	-0.189 ***	0.06
		(0.017)	(0.049)	
Guayaquil	223	0.013	-0.131 ***	0.04
		(0.016)	(0.046)	
Latacunga	223	0.010	-0.147 ***	0.06
		(0.015)	(0.038)	
Loja	223	0.047 ***	-0.214 ***	0.10
		(0.016)	(0.044)	
Machala	223	0.025	-0.108 **	0.03
		(0.016)	(0.043)	
Manta	223	0.045 ***	-0.233 ***	0.14
		(0.016)	(0.040)	
Portoviejo	223	0.015	-0.173 ***	0.07
		(0.015)	(0.041)	
Quevedo	223	0.016	-0.165 ***	0.07
		(0.017)	(0.039)	
Riobamba	223	-0.024	-0.225 ***	0.08
		(0.017)	(0.051)	

Note: The Increase in Price is obtained as the After value minus the Before value. The Before and After values are time averages for the periods Jan 97-Dec 98 and Jul 01-Apr 03, respectively. The months from Jan 99 to Jun 01 are considered transitional. OLS standard errors are reported in parentheses. (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimate at 10%, 5% and 1%, respectively. Results are robust to heteroscedasticity. The estimated equation is $\Delta q = \alpha + \beta q_{Before} + \varepsilon$, where Δq is the change in price and q_{Before} is the initial price.

The results at the commodity level, however, are supportive of absolute convergence, although weakly. For all cities in Table 3.6, the estimated β coefficient is negative and statistically significant. However, the R^2 values of the regressions are very

small indicating that there must be other factors that explain the change in price after the start of dollarization better than a convergence process. Figure 3.5 shows a scatter plot of the change in relative price versus the initial relative price for Ambato (the other cities show a similar pattern.) According to Figure 3.5, most commodities are in the convergence quadrants, i.e. those where the change in price and the initial price have opposite signs, but some are in quadrants that indicate divergence. These commodities clearly contribute to the noisiness of the relationship. However, no commodity or cluster of commodities seems to be driving the estimated negative relationship.



Note: There is one dot for each of 223 commodities. Prices are relative with respect to Quito, and the change in relative price is from "Before" to "After" the start of dollarization in Ecuador. The change in relative price is plotted on the vertical axis and the initial relative price on the horizontal axis. The initial relative price is the same as the "Before" price. The "Before" and the "After" prices are estimated, excluding the transition months from January 1999 to June 2001.

Figure 3.5. Ambato: Change in Price versus Initial Price

With respect to the first robustness analysis, Table 3.7 shows the results of estimating the time series regressions (3.10) and (3.11) using the city-specific relative prices, $q_{i,t}$, and the series for the spread of the commodity relative prices, $s_{i,t}$.

Table 3.7. Time-Series Regressions of Mean Relative Price and Spread of Commodity Relative Prices on an Intercept and a Dollarization Dummy

	Mean Relative Price		Spread of Relative Prices	
City	α_0	α_1	β_0	β_1
Ambato	-0.082 ***	0.024 ***	0.318 ***	-0.003
	(0.003)	(0.005)	(0.005)	(0.005)
Cuenca	-0.048 ***	0.073 ***	0.305 ***	0.009 **
	(0.004)	(0.007)	(0.002)	(0.003)
Esmeraldas	-0.059 ***	0.021 **	0.376 ***	0.024 ***
	(0.005)	(0.011)	(0.004)	(0.007)
Guayaquil	-0.038 ***	0.013 *	0.370 ***	0.019 ***
	(0.006)	(0.008)	(0.003)	(0.004)
Latacunga	-0.100 ***	0.016 ***	0.411 ***	0.001
	(0.003)	(0.006)	(0.004)	(0.005)
Loja	-0.086 ***	0.058 ***	0.376 ***	0.010
	(0.005)	(0.010)	(0.004)	(0.006)
Machala	-0.057 ***	0.015	0.403 ***	0.020 ***
	(0.006)	(0.011)	(0.007)	(0.007)
Manta	-0.064 ***	0.038 ***	0.423 ***	-0.003
	(0.005)	(0.011)	(0.008)	(0.012)
Portoviejo	-0.024 ***	0.014 *	0.404 ***	0.010
	(0.007)	(0.008)	(0.006)	(0.010)
Quevedo	-0.149 ***	0.026 **	0.427 ***	-0.003
	(0.008)	(0.011)	(0.006)	(0.007)
Riobamba	-0.147 ***	0.008 *	0.337 ***	0.027 **
	(0.003)	(0.005)	(0.008)	(0.011)
Pooled:	-0.078 ***	0.028 ***	0.377 ***	0.010 ***
	(0.001)	(0.001)	(0.001)	(0.002)

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimate at 10%, 5% and 1%, respectively. Tests in regressions use Newey-West HAC standard errors and covariance. Standard errors are reported in parentheses. All time series are from Jan 97 to Apr 03 (76 months.) The dollarization dummy variable takes on the value 1 from Jan 00 to Apr 03 (40 months.) Intercept coefficients are α_0 and β_0; Dummy variable coefficients are α_1 and β_1. Pooled estimates assume common coefficients across cities.

The results are consistent with the previous results. First, all coefficients α_0 are negative and statistically significant indicating that price levels in the cities were below the Quito level before dollarization. Second, the estimated α_1 coefficient for the dollarization dummy is positive and statistically significant at 10% significance or better for 10 of the 11 cities, indicating a movement of the cities' price levels to the Quito level. Only for Machala, α_1 is non-significant although still positive. Third, the pooled results show that the estimated increase in relative price, 0.028, would only narrow the difference between the initial level, -0.078, and the zero line. Fourth, with respect to the spread of commodity relative prices, there is a significant but small increase detected for only five of the 11 cities (i.e. β_1 is positive and significant.)

To investigate whether the results in Table 3.7 may have been driven by outlier commodities, regressions (3.10) and (3.11) are estimated using the median and the inter-quartile range of the commodity relative prices for each city. The results are shown in Table 3.8. Although when the median and the inter-quartile range are used, the estimates are smaller than when the mean and the standard deviation are used, the implications of the results in Table 3.8 are the same as those in Table 3.7.

Table 3.9 shows the results of estimating equation (3.12) assuming that each city relative price, $q_{i,t}$, follows a first-order autoregressive process.[69] In Table 3.9, the coefficient for the dollarization dummy, α_1, is significant at 10% for seven of the 11 cities, and in all cases is positive. In addition, the calculated "Before" and "After" values for the mean relative price levels are very similar to the values shown in part A of Table

[69] Certain results in Table 3.9 should be interpreted with care. The Durbin-Watson (DW) statistics for Portoviejo, Quevedo and Manta are low, indicating the possibility of serial correlation in the errors. If that is the case, these cities' estimates in Table 3.9 would be biased and inconsistent. Actually, a Breusch-Godfrey Lagrange Multiplier test indicates serially correlated errors for these cities' relative price series although in a lower degree for Manta.

3.5 used in the pre-post tests. The time-series results in Table 3.9, thus, corroborate the validity of the cross-sectional pre-post tests.

Table 3.8. Time-Series Regressions of Median Relative Price and Inter-Quartile Range of Relative Prices on an Intercept and a Dollarization Dummy

	Median Relative Price		Inter-Quartile Range of Relative prices	
City	α_0	α_1	β_0	β_1
Ambato	-0.024 ***	0.015 ***	0.277 ***	0.003
	(0.002)	(0.004)	(0.007)	(0.008)
Cuenca	-0.019 ***	0.036 ***	0.238 ***	-0.002
	(0.004)	(0.005)	(0.008)	(0.009)
Esmeraldas	-0.008 **	0.008 *	0.299 ***	0.001
	(0.003)	(0.004)	(0.007)	(0.010)
Guayaquil	-0.005 **	0.006	0.270 ***	0.028 ***
	(0.002)	(0.004)	(0.006)	(0.009)
Latacunga	-0.029 ***	0.019 ***	0.307 ***	-0.005
	(0.003)	(0.005)	(0.008)	(0.009)
Loja	-0.037 ***	0.036 ***	0.328 ***	0.001
	(0.003)	(0.007)	(0.006)	(0.009)
Machala	-0.009 **	0.005	0.322 ***	-0.005
	(0.004)	(0.007)	(0.005)	(0.010)
Manta	-0.016 ***	0.022 ***	0.335 ***	0.003
	(0.004)	(0.006)	(0.015)	(0.019)
Portoviejo	0.005 *	0.007 *	0.331 ***	0.003
	(0.003)	(0.004)	(0.010)	(0.013)
Quevedo	-0.052 ***	0.019 **	0.386 ***	-0.042 ***
	(0.007)	(0.009)	(0.006)	(0.008)
Riobamba	-0.074 ***	0.014 **	0.285 ***	0.000
	(0.005)	(0.006)	(0.009)	(0.012)
Pooled:	-0.024 ***	0.017 ***	0.307 ***	-0.001
	(0.001)	(0.001)	(0.002)	(0.002)

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimate at 10%, 5% and 1%, respectively. Tests in regressions use Newey-West HAC standard errors and covariance. Standard errors are reported in parentheses. All time series are from Jan 97 to Apr 03 (76 months.) The dollarization dummy variable takes on the value 1 from Jan 00 to Apr 03 (40 months.) Intercept coefficients are α_0 and β_0; Dummy variable coefficients are α_1 and β_1. Pooled estimates assume common coefficients across cities.

Table 3.9. City Relative Price Regressed on a Dollarization Dummy and the Lagged Relative Price

City	α_0	α_1	ρ	R^2	DW	Half Life	Before	After
Ambato	-0.024 ***	0.008 ***	0.704 ***	0.73	2.07	1.97	-0.083	-0.055
	(0.007)	(0.003)	(0.082)					
Cuenca	-0.008 **	0.014 ***	0.814 ***	0.95	2.08	3.37	-0.045	0.033
	(0.003)	(0.005)	(0.057)					
Esmeraldas	-0.011 **	0.007 *	0.833 ***	0.74	1.82	3.80	-0.066	-0.025
	(0.005)	(0.004)	(0.063)					
Guayaquil	-0.010 **	0.005	0.756 ***	0.62	1.57	2.48	-0.039	-0.020
	(0.004)	(0.004)	(0.074)					
Latacunga	-0.027 ***	0.006 **	0.740 ***	0.62	1.77	2.30	-0.103	-0.079
	(0.008)	(0.003)	(0.083)					
Loja	-0.021 ***	0.016 ***	0.765 ***	0.85	2.07	2.59	-0.087	-0.020
	(0.006)	(0.005)	(0.064)					
Machala	-0.010 **	0.007	0.850 ***	0.73	1.75	4.26	-0.069	-0.024
	(0.005)	(0.004)	(0.063)					
Manta	-0.010 **	0.009 **	0.859 ***	0.84	1.50	4.58	-0.072	-0.008
	(0.004)	(0.004)	(0.055)					
Portoviejo	-0.005 *	0.004	0.769 ***	0.65	1.39	2.64	-0.023	-0.006
	(0.003)	(0.003)	(0.072)					
Quevedo	-0.027 **	0.005	0.821 ***	0.74	1.49	3.51	-0.149	-0.120
	(0.010)	(0.004)	(0.067)					
Riobamba	-0.048 ***	0.005 *	0.679 ***	0.52	1.80	1.79	-0.151	-0.136
	(0.012)	(0.003)	(0.083)					

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimates at 10%, 5% and 1%, respectively. Standard errors are in parentheses. All time series are from Jan 97 to Apr 03 (76 months.) The dollarization dummy variable takes on the value 1 from Jan 00 to Apr 03 (40 months.) The estimated model is: $q_{i,t} = \alpha_0 + \alpha_1 D_{i,t} + \rho q_{i,t-1} + \varepsilon_{i,t}$. Half-lives are calculated as $-Ln(2)/Ln(\rho)$ and are in months. The Before and After values are calculated as $\alpha_0/(1-\rho)$ and $(\alpha_0+\alpha_1)/(1-\rho)$, respectively.

Table 3.9 also shows estimates of the persistence of the relative price series, ρ, and the corresponding half-life of disturbances to the series. These estimates show rapid mean return after shocks. Deviations from equilibrium of the relative price series for Ambato and Riobamba are cut in half within two months. The slowest-adjusting series are those for Machala and Manta with half-lives of just over 4 months. The difference in persistence could be due in part to the distance existent between the cities and Quito. In

fact, the correlation between the estimated ρ and distance is a positive 0.49, although not significant (p-value = 0.13.) This result is consistent with Parsley and Wei's (1996) finding for U.S. cities that locations farther apart have more persistent price deviations, but that distance alone is not enough to fully explain the differences in persistence.

With respect to the panel analyses, Tables 3.10 and 3.11 show the results of estimating equations (3.13) and (3.14), respectively. The results in Table 3.10 can be compared with those in Table 3.7 which are for regressions using the city relative price series as the dependent variable. The panel results give roughly the same intercepts, α_0, but the dummy-variable coefficients, α_1, are smaller. This latter result is due to the correction for cross-commodity heteroscedasticity in the panel analysis. When this correction is eliminated, the coefficients become roughly the same. In any case, the dollarization dummy coefficients, α_1, are all positive and statistically significant. These results, however, may not be reliable due to the presence of serial correlation as indicated by the low Durbin-Watson statistic values reported in Table 3.10.

Table 3.11 shows the result of estimating Equation (3.11) for each city. This equation assumes that each commodity relative price follows a first-order autoregressive process, in an effort to control for serial correlation. In Table 3.11, the coefficient for the dollarization dummy, α_1, is positive for all 11 cities and statistically significant for 9 at 10% significance or better. The size of coefficient α_1 is larger in this estimation than when the city relative prices were used as shown in Table 3.9. Comparing Table 3.11 with Table 3.9 also indicates that the persistence estimates are more homogeneous in Table 3.11, with half-lives for deviations to the relative price series from 1.82 to 2.95 months (In Table 3.9 they ranged from 1.79 to 4.58 months.) The overall results in Table

3.11 continue to be consistent with the previous results that prices of commodities in the other cities and Quito became on average more similar after the start of dollarization.

Table 3.10. Panel Regressions of Commodity Relative Price on a Constant and a Dollarization Dummy

City	α_0	α_1	R^2	DW
Ambato	-0.077 ***	0.015 ***	0.79	0.53
	(0.001)	(0.001)		
Cuenca	-0.031 ***	0.042 ***	0.79	0.54
	(0.001)	(0.001)		
Esmeraldas	-0.051 ***	0.006 ***	0.75	0.54
	(0.001)	(0.001)		
Guayaquil	-0.032 ***	0.002 **	0.78	0.59
	(0.001)	(0.001)		
Latacunga	-0.096 ***	0.008 ***	0.79	0.52
	(0.001)	(0.001)		
Loja	-0.079 ***	0.044 ***	0.80	0.48
	(0.001)	(0.002)		
Machala	-0.052 ***	0.005 ***	0.80	0.54
	(0.001)	(0.001)		
Manta	-0.049 ***	0.010 ***	0.83	0.46
	(0.001)	(0.001)		
Portoviejo	-0.018 ***	0.002 *	0.86	0.52
	(0.001)	(0.001)		
Quevedo	-0.138 ***	0.005 ***	0.82	0.55
	(0.001)	(0.001)		
Riobamba	-0.144 ***	0.003 ***	0.78	0.55
	(0.001)	(0.001)		

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimate at 10%, 5% and 1%, respectively. Standard errors are reported in parentheses. For each city, the panel consists of 223 commodity relative-price series from Jan 97 to Apr 03 (76 months.) The dollarization dummy takes on the value 1 from Jan 00 to Apr 03 (40 months.) All regressions assume commodity-level fixed effects, and their means are reported as the α_0 values. Results are robust to cross-commodity heteroscedasticity. The estimated model is $q_{i,j,t} = \alpha_{0i} + \alpha_{1i}D_{i,j,t} + \varepsilon_{i,j,t}$.

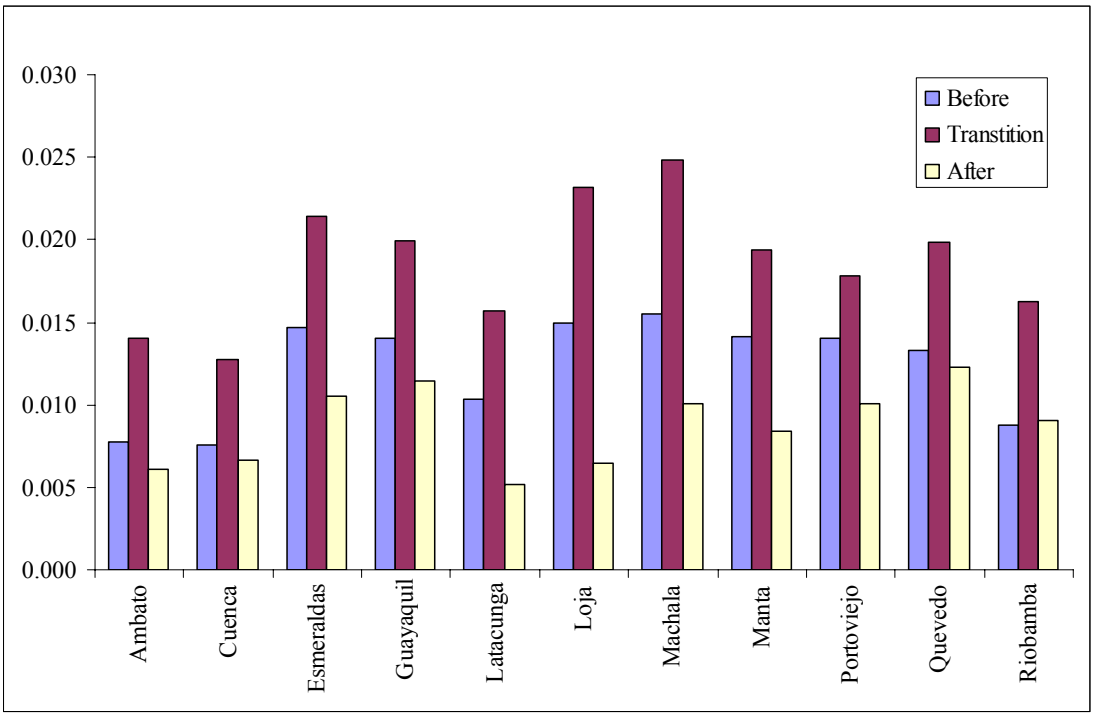
Table 3.11. Dynamic Panel Regressions of the Commodity Relative Price on a Dollarization Dummy

City	α_1		ρ		Half Life
Ambato	0.033	***	0.727	***	2.18
	(0.011)		(0.020)		
Cuenca	0.030	*	0.716	***	2.07
	(0.016)		(0.026)		
Esmeraldas	0.033	**	0.747	***	2.38
	(0.015)		(0.014)		
Guayaquil	0.041	***	0.710	***	2.02
	(0.015)		(0.023)		
Latacunga	0.037	**	0.711	***	2.03
	(0.015)		(0.022)		
Loja	0.014		0.759	***	2.52
	(0.009)		(0.016)		
Machala	0.017		0.736	***	2.26
	(0.013)		(0.015)		
Manta	0.025	**	0.791	***	2.95
	(0.012)		(0.013)		
Portoviejo	0.042	**	0.766	***	2.60
	(0.019)		(0.018)		
Quevedo	0.025	**	0.734	***	2.24
	(0.012)		(0.033)		
Riobamba	0.019	*	0.683	***	1.82
	(0.010)		(0.029)		

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimate at 10%, 5% and 1%, respectively. Standard errors are in parentheses. For each city, the panel consists of 223 commodity relative-price series from Jan 97 to Apr 03 (76 months.) The dollarization dummy takes on the value 1 from Jan 00 to Apr 03 (40 months.) The model assumed is $q_{i,j,t} = \alpha_{0i} + \alpha_{1i}D_{i,j,t} + \rho q_{i,j,t-1} + \varepsilon_{i,j,t}$, and is estimated using the Arellano and Bond (1991) method for dynamic panels. Because of the first-differencing, the intercept is lost. All panels use 759 instruments generated from using lags -2 to -12 of the relative price series. Half lives are in months and are calculated as $-Ln(2)/Ln(\rho)$.

Before ending this section, an important result needs to be mentioned. In section 2.1, evidence was shown that after the start of dollarization in January 2000, the volatility of the CPI-based RER declined not only because nominal exchange rate volatility was eliminated, but also because price volatility was reduced. This result also holds for RERs

calculated for each of the 12 Ecuadorian cities.[70] According to Engel and Rogers (1996) the mere decline in RER volatility implies a narrowing of the "border" between Ecuador and the U.S. Figure 3.6, suggests that something similar has happened within Ecuador between the 11 cities and Quito after the adoption of dollarization, even though there is no exchange rate involved.



Note: Relative prices are of the cities with respect to Quito. Volatility of the relative price is defined as the standard deviation of the relative price growth rate series in each period. The "Before" period is from Jan 97 to Dec 98; the "Transition" period from Jan 99 to Jun 01; and the "After" period from Jul 01 to Apr 03. Dollarization started in Jan 2000. The "Before" and "After" cross-city average volatility values are 0.0123 and 0.0087, respectively. The difference, 0.0035, is statistically significant according to both a matched-sample t-test (t-stat = -4.46, p-value = 0.001), and a Wilcoxon, non-parametric test (value = 2.43, p-value = 0.015.)

Fig. 3.6. Volatility of The City Relative Price Before and After the Start of Dollarization for 11 Ecuadorian Cities

[70] For this, the CPI of Ecuador is replaced with the price level of each city in the calculation of the RER. The city price levels are obtained as the city averages of the 223 commodity prices ($p_{i,j,t}$ in equation (3.2)) for the city. Results of the volatility analysis between the Ecuadorian cities and the U.S. are not reported in this study.

According to Figure 3.6, the volatility of the relative price of the cities with respect to Quito has declined, and the mean decline is statistically significant. Figure 3.6 also shows how costly, in terms of uncertainty, was the transition period which included the crisis year. The decline in relative price volatility provides more evidence of increased price integration between the cities and Quito after the adoption of the new regime.

5. Conclusion

In January 2000, Ecuador replaced Panama as the largest independent country in the world to use the U.S. dollar as its official currency. With dollarization, the country gave up its control of monetary policy, seigniorage revenue, and the possibility of using devaluation to gain trade competitiveness. These are some of the costs, but what are the benefits? This chapter shows how the adoption of Dollarization marks the end of the worst currency crisis experienced by Ecuador in its entire history. It also shows how aggregate and commodity-level prices that had become depreciated in dollar terms during the crisis were put in a recovery mode towards pre-crisis levels.

In this chapter, it is shown that the behavior of a set of commodity relative prices of Ecuador, with respect to the U.S., closely resemble that of the aggregate real exchange rate on average. These relative prices are found to be stationary as a group with half-lives of deviations of about 12 months. When the crisis and recovery episodes are controlled for with the use of structural breaks, the stationarity results become stronger and the estimated half-lives for the average commodity reduces to less than 2 months. For the aggregate real exchange rate, the half-life of deviations declines from 16 to about 5

months when the breaks are used. These estimates are significantly less than the consensus in the cross-country PPP literature of three to five years.

In this chapter, evidence of increased price integration between 11 Ecuadorian cities and the capital city, Quito, is also presented. Using several econometric approaches, it is shown that the price levels of the other cities and Quito have moved closer. This movement, however, is not consistent with absolute convergence or with an overall integration of all the cities. The spread of the city price levels does not decrease with dollarization. In addition, the average spread of commodity prices in the cities relative to Quito is hardly affected. The price integration process seems to be limited by particular characteristics of the cities which cannot change much in the short run.

At the commodity level, there are weak signs of absolute convergence. Prices that were initially farther from the Quito level do tend to experience the larger shifts with dollarization. However, the convergence relationship of commodity relative prices is very noisy indicating that important factors are being ignored.

An interesting finding of the intra-national analysis is that even within a small country like Ecuador, relative price disturbances do not die out fast enough. Deviations from price parity show a half-life in the range from 2 to 3 months, comparable to the half-life estimates for relative prices between Ecuador and the U.S.

An important finding is that, both in the international and the intra-national context, the adoption of dollarization in Ecuador shows signs of integrating effects in terms of what Engel and Rogers' (1996) would interpret as a reduction of national borders. In the international context, the volatility of the CPI-Based real exchange rate has declined after the adoption of dollarization, not only because of the elimination of nominal exchange

rate volatility but also because of a decline in price volatility. In the intra-national context, even without the existence of an exchange rate, the volatility of the relative price between the individual cities and Quito has declined after the adoption of dollarization.

CHAPTER IV

DOLLARIZATION AND PRICE DYNAMICS IN THE LONG RUN

1. Introduction

This chapter presents a comparative study of long-run price level convergence under dollarization and other alternative exchange rate regimes. The study is done in a Latin American context but focuses on Panama, a country that has been dollarized since 1904. According to the literature on dollarization, after over 100 years, Panama must have become very integrated to the anchor country, the U.S., in several aspects which include the price level. The degree of price level integration should at least be higher than that observed for the average non-dollarized Latin American country; however, the results of this study contradict this hypothesis.

Apparently, inflation convergence after the adoption of a credible hard-peg can happen fairly quickly. High-inflation countries have successfully used exchange-rate-based stabilization programs to reduce inflation to U.S. levels. For example, as indicated by Uribe (1997), the year before the start of the Argentinean convertibility plan in April 1991, which fixed the exchange rate between the peso and the U.S. dollar, the inflation rate averaged a monthly 12%; this rate fell to 2.2%, 1%, and 0.4% in the first, second and third year, respectively, under the plan. The more recent experience of Ecuador shows a similar result. The inflation rate fell from an average of 40% annually for the four years before the adoption of dollarization in January 2000, to 22.4%, 9.4%, 6.1%, and 2%, in

2001, 2002, 2003 and 2004, respectively, under the new system.[71] Price *level* convergence, on the other hand, may seem to take much longer.

Purchasing Power Parity (PPP) would be the theoretical justification for long-run price level convergence. As indicated by Rogoff (1996), the consensus in the recent literature is that PPP holds in the long run, with deviations from PPP vanishing at a rate of just 15% per year. In fact, temporary inflation differentials are consistent with long-run price level convergence as Rogers (2001) suggests in a study with euro-area countries. According to Rogers, inflation rates must be higher in countries with lower initial price levels than countries with higher price levels, if they are to converge to a common level of prices. The use of a common currency should favor this process, first because nominal exchange volatility is eliminated, and second because it may lead to further integration in other aspects. Trade integration would promote price equalization for tradable commodities. If, in addition, there is productivity convergence in the production of tradables, the prices of non-tradables would also tend to converge as predicted by the Balassa (1964, 1973) and Samuelson (1964) hypothesis.

The literature on Optimum Currency Areas (OCA), pioneered by Mundell (1961), suggests certain integrating effects of dollarizing, i.e. of joining the "dollar currency area." According to Frankel (2001), an increase in financial integration and a further expansion in trade between the dollarized and the anchor country can be expected. Rose (2000) shows in a broad panel data study that after controlling for other factors, two countries sharing the same currency trade three times as much as they would with

[71] The first year under dollarization (2000), the annual inflation rate in Ecuador was 91%, higher than in the previous years. This was due to a quick recovery of the real exchange rate from an extreme depreciation episode that occurred during the Ecuadorian currency crisis in 1999. See Chapter III for an explanation of this phenomenon. Note: Ecuador's inflation rates are obtained from the National Institute of Statistics and Censuses of Ecuador (INEC.)

different currencies. Glick and Rose (2002) found that a country that leaves a currency union could experience a decline in bilateral trade. Frankel and Rose (2002) corroborate the positive effect of a common currency on trade, and in addition find no evidence of trade diversion. They even find a positive effect on income per capita, which is consistent with the results in Frankel and Romer (1999) that trade causes growth.[72] All these effects contribute to a greater integration between the dollarized country and the U.S. and to a better business cycle correlation.[73] This can lead to convergence in non-tradable prices with the resulting overall price level convergence between the two countries.

This study must be one of the few, if not the first, that analyzes price level convergence specifically under dollarization. The OCA literature investigates the use of a common currency and its effect on certain aspects such as trade and income, but not on price levels. Studies in the line of Froot and Rogoff (1991) and Rogers (2001) examine price level convergence but only for the euro area, and others, such as Cecchetti, Mark, and Sonora (2000) and Parsley and Wei (1996) examine it in the context of U.S. cities. Moreno-Villalaz (1999) evaluates Panama's experience with dollarization but in terms of its stability and degree of international financial integration. Goldfajn and Olivares (2001) only analyze the effects of dollarization on Panama's economic performance and immunity to general confidence shocks.

This chapter presents evidence that dollarization has not resulted in price level integration between Panama and the U.S. and provides an explanation for that. The

[72] Frankel and Rose (2002) combine the estimation results of cross-section gravity and growth models to calculate the expected effect of dollarization on trade and also on real income over a period of 20 years for several countries. For example, for a recently dollarized country like Ecuador, dollarization implies a doubling of trade as a percentage of GDP and an increase of 17% in real per-capita income (see also Frankel, 2001). Frankel and Rose also estimate the expected effects for the adoption of the euro instead of the U.S. dollar.

[73] Corsetti and Pesenti (2004) suggest that business cycles would become more synchronized even in the absence of trade or real economic integration.

chapter is organized as follows: Section 2 describes the relative price and income data used. It also evaluates the long-run economic performance of the countries involved. Section 3 examines the stationarity of the real exchange rates of Panama and other 12 Latin American countries and finds general violations to PPP, particularly by Panama. Section 4 presents an analysis with relative price levels, the results of which indicate that the price levels of Panama and the average Latin American country have diverged from the U.S. price level during the period of analysis. The price levels of the countries seem to instead be converging to a positive relationship with the income level, just as prescribed by the Balassa (1964, 1973) and Samuelson (1964) hypothesis. Section 5 presents a descriptive analysis with price levels of non-tradables and tradables that finds that the former is driving Panama's price level divergence. Section 6 concludes.

2. The Data

For this study of long-run price level convergence under dollarization, Panama is the natural choice considering that it has been dollarized for over 100 years. However, because it is the only country with that characteristic, no control can be made for factors other than the dollarized system that could also be driving the price dynamics. For this reason, 12 other non-dollarized Latin American countries are used for comparison purposes. These countries are chosen on account of data availability and are: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, Paraguay, Peru, Uruguay, and Venezuela. In this study, all the data are annual and cover the period 1950-2000, with a few exceptions.

Convergence is examined using two relative price measures both having the U.S. as the numeraire country. The first measure is the bilateral real exchange rate between each country *i* and the U.S. at each year *t*, called $q_{i,t}$, which is defined in log terms as:

$$q_{i,t} = p_{i,t} - e_{i,t} - p_t^* \tag{4.1}$$

where $e_{i,t}$ is the log of the nominal exchange rate in units of country *i*'s domestic currency per dollar, and $p_{i,t}$ and p_t^* are the logs of the consumer price indices (CPI) of country *i* and the U.S., respectively. The nominal exchange rate is the variable *xrat* obtained from the Heston-Summers-Aten Penn World Table version 6.1 (PWT) of the Center for International Comparisons at the University of Pennsylvania (CICUP), and the CPIs are obtained from the IMF International Financial Statistics (IFS).[74] Because $q_{i,t}$ is based on price indices, its level is not relevant, but its changes over time provide meaningful information on the movement of each country's general price level with respect to the U.S. level. The real exchange rate is the obvious choice and the most available variable for studies about PPP and relative price level movement between countries. Results based on it are easily interpreted in terms of interactions between familiar concepts such as nominal exchange depreciation and differential inflation.

The other measure is the common-currency relative price level between country *i* and the U.S. at time *t*, called $q'_{i,t}$. This measure is analogous to $q_{i,t}$ and is calculated as:

$$q'_{i,t} = \ln\left(\frac{pc_{i,t}}{pc_t^*}\right) \tag{4.2}$$

where $pc_{i,t}$ and pc_t^* are the price levels of consumption of country *i* and the U.S., respectively, both obtained from the PWT. The *pc* variables are the ratio of the PPP of

[74] The PWT instead of the IFS was chosen as the source for the nominal exchange rate data, because for countries with many changes of currency, the PWT series were more reliable.

consumption to the nominal exchange rate, *xrat*, for each country. The PPP of consumption is, in turn, the ratio of the price in units of a country's domestic currency of a selected bundle of consumption commodities to the price of the same bundle in "international dollars," this ratio expressed in units of the country's domestic currency per U.S. dollar. The *pc* series have thus no units, but their absolute values provide meaningful information on the countries' price levels. According to the CICUP, these price levels are not only comparable across the years for a given country, but also across countries. However, to obtain international comparability, country specificity is sacrificed. For example, PWT price levels for a given country are calculated using information from the other countries in the world, not just that country or the set of countries used in this analysis, so that these price levels are not the best trackers of inflation.

In addition to the relative price measures, this study uses a measure of relative per-capita income, which can also be interpreted as a proxy for relative productivity. This measure is the common-currency relative real per-capita GDP level between country *i* and the U.S. at time *t*, and is calculated as:

$$y'_{i,t} = \ln\left(\frac{rgdpch_{i,t}}{rgdpch_t^*}\right) \tag{4.3}$$

where $rgdpch_{i,t}$ and $rgdpch_t^*$ are the real per-capita GDP chain series in constant international dollars of 1996 for country *i* and the U.S., respectively, both obtained from the PWT. Real series are used in order to eliminate nominal price effects. Similarly to the *pc* variables in equation (4.2) above, the PWT real per-capita GDP values are comparable across years and countries by construction.[75]

[75] More information on the PWT can be obtained from its website http://pwt.econ.upenn.edu/. Also see Kravis, Heston, and Summers (1982).

2.1. Long-Run Economic Performance of the Countries

Before providing statistics for the relative price and income variables just described, it is useful to evaluate the economic performance and trade characteristics of the countries in the sample during the period of analysis. Table 4.1 presents descriptive statistics on inflation, nominal exchange rate depreciation, real per-capita GDP growth, openness, and the share of the U.S. in the countries' trade for the Latin American countries, including Panama, and the U.S. for two sub-periods: 1950-1971 and 1972-2000. The breaking point is 1971, the year when the Bretton-Woods period of fixed exchange rates effectively ended. The statistics presented in Table 4.1 are all relevant to this study considering that, according to the OCA literature, small and open economies that trade heavily with the U.S. are good candidates for dollarization, particularly if they suffer from chronic inflation and want to stabilize by importing U.S. inflation.

It is striking in Table 4.1 that during sub-period 1950-1971, while many of the world's nations were under (roughly) fixed exchanged rates with respect to the dollar, Argentina, Brazil, Chile and Uruguay experienced large currency depreciations of as much as 20% per year on average, or more. Colombia and Paraguay did so to a lower degree (just over 10% per year on average.) Costa Rica, Ecuador, Mexico, and Peru also experienced depreciations, but they were minor (not more than 5% per year on average.) Guatemala and, obviously Panama under its dollarized system, were the only countries in the sample with no currency depreciation during this sub-period.

During the first sub-period, inflation seems to have counteracted the nominal exchange rate depreciations, but without preventing several countries from performing relatively well. The average Latin American country had an annual inflation rate of

Table 4.1. Economic Performance of 13 Latin American Countries and the U.S.

	Inflation		Exchange Rate Depreciation		Growth of Real per-Capita GDP		Openness		Share of U.S. in Trade	
Sub-Period 1950-1971										
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Argentina	22.27	15.11	22.79	26.18	1.92	5.28	12.2	2.5	16.2	2.5
Brazil [a]	-	-	26.99	20.12	4.12	2.88	14.8	3.1	35.1	6.6
Chile	26.79	12.93	26.99	18.48	2.15	4.06	25.9	3.6	39.8	10.2
Colombia	8.59	6.68	11.07	14.57	1.90	2.12	27.0	3.2	58.0	13.5
Costa Rica	2.10	2.02	0.79	2.61	2.60	4.27	53.9	5.0	52.4	12.6
Ecuador	2.92	2.82	2.55	5.52	1.83	2.22	34.9	2.2	53.9	7.5
Guatemala	0.79	1.64	0.00	0.00	1.63	1.96	29.9	4.9	54.1	19.4
Mexico	4.95	4.32	1.75	6.19	2.99	2.82	23.6	5.4	69.1	6.6
Panama	0.82	1.26	0.00	0.00	3.38	3.92	80.6	4.1	65.8	13.4
Paraguay	14.29	19.20	14.98	23.41	0.95	3.39	30.2	3.7	19.3	5.0
Peru	8.14	3.34	4.58	9.21	3.10	4.52	38.8	3.5	38.4	4.0
Uruguay	25.76	20.28	21.65	26.70	0.71	5.17	26.7	4.7	20.3	11.9
Venezuela	1.54	2.33	0.81	7.86	2.31	4.62	43.8	3.8	46.0	3.3
Average:	9.91	7.66	10.38	12.37	2.28	3.63	34.0	3.8	43.7	9.0
USA	2.48	1.99	0.00	0.00	2.15	2.59	9.5	0.8	-	-
Sub-Period 1972-2000										
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Argentina	88.87	91.17	82.14	97.47	0.46	6.32	16.4	3.4	14.9	1.9
Brazil [a]	128.57	111.59	95.11	99.70	2.08	4.14	17.9	2.5	21.5	2.2
Chile	37.62	48.87	36.86	56.34	2.25	6.12	52.0	10.4	19.4	1.9
Colombia	19.93	4.59	16.04	8.39	1.70	1.99	32.0	4.0	36.8	3.6
Costa Rica	16.38	11.59	13.24	18.75	1.08	3.80	76.7	11.4	41.8	6.3
Ecuador	26.70	15.12	23.82	23.66	1.33	5.28	53.8	7.8	39.3	5.4
Guatemala	11.41	7.96	7.07	14.72	0.87	2.37	41.3	6.8	35.0	4.4
Mexico	28.20	21.58	22.86	29.31	1.55	3.55	36.6	14.8	70.6	7.5
Panama	3.29	3.72	0.00	0.00	1.43	4.80	82.0	13.2	42.5	3.0
Paraguay	15.21	7.31	11.45	17.41	1.64	4.08	55.4	24.7	7.5	2.0
Peru	70.46	101.07	63.16	96.97	-0.14	6.45	31.9	6.4	27.8	4.8
Uruguay	42.78	18.71	37.23	21.35	1.56	5.25	40.0	6.2	9.2	1.2
Venezuela	22.29	17.44	17.34	25.31	-1.39	3.49	48.4	7.0	45.3	4.2
Average:	39.36	35.44	32.79	39.18	1.11	4.43	44.9	9.1	31.7	3.7
USA	4.99	2.96	0.00	0.00	2.35	2.55	19.6	3.3	-	-

Note: All values in the table are percentages. Inflation rates are based on CPI series from the IMF-IFS. Exchange rate depreciation, real per-capita GDP growth, and openness are based on the variables xrat, rgdpch, and openc, obtained from the Penn World Table v6.1 (PWT). Exchange rates are nominal and in units of domestic currency per U.S. dollar. Openness is defined as total trade (i.e. imports + exports) as a percentage of GDP. The share of the U.S. in each country's trade is the simple average of the imports and exports shares, and is based on trade data from the UN International Trade Statistics Yearbook, several issues. Statistics are based on annual data for all variables except the U.S. shares for which the data are every 5 years. PWT data for 1950 is missing for Chile, Ecuador and Paraguay.

([a]) Brazil inflation statistics are for 1980-2000 because there are IFS CPI data for that period only.

9.91%, slightly lower than the annual currency depreciation rate of 10.38%. However, Costa Rica, Guatemala, Panama and Venezuela had lower inflation rates than the U.S. (2.10%, 0.79%, 0.82%, and 1.54%, respectively, versus 2.48% per year for the U.S.) In addition, mean real per-capita GDP growth was slightly better for the average Latin American country than for the U.S. (compare 2.28% to 2.15%), and some countries such as Brazil, Chile, Costa Rica, Mexico, Panama, Peru and Venezuela did equally well or even better (4.12%, 2.15%, 2.60%, 2.99%, 3.38%, 3.10%, and 2.31%, respectively.) Still, the U.S. did slightly better in terms of real income volatility (The standard deviation of real per-capita GDP growth is 2.59% and 3.63 for the U.S. and the average Latin American country, respectively.)

The situation is different in sub-period 1972-2000, with an overall poor performance of the Latin American countries. First, inflation and currency depreciation accelerated significantly. The average Latin American country's mean inflation was 39.36% per year, much higher than the 4.99% of the U.S. or the 9.91% for the first sub-period, and much more volatile. Domestic currency depreciation occurred at an average annual rate of 32.79%. Second, income growth stagnated. Real per-capita GDP growth slowed down to an average of only 1.11% per year, less than the 2.35% for the U.S. In fact, no Latin American country outperformed the U.S., and some countries such as Peru and Venezuela even experienced negative mean growth. Chile's mean growth rate, 2.25%, was the highest among the Latin American countries, but it was also one of the most volatile, with a standard deviation of 6.12%. It is important to notice that Panama's real per-capita GDP growth is similar to that of the average Latin American country in both mean and standard deviation (Compare the mean=1.43% and std=4.80% for Panama with

the mean=1.11% and std=4.43% for the average Latin American country.) However, in terms of inflation and price volatility, Panama is outstanding, with a mean annual inflation of just 3.29% (less than for the U.S.) and a standard deviation of 3.72%.

With respect to trade, Table 4.1 shows that most countries became more open over time. For the average Latin American country, total trade (i.e. imports plus exports) as a percentage of GDP increased from 34.0% in the sub-period 1950-1971 to 44.9% in the sub-period 1972-2000. Still, the largest countries, Argentina, Brazil and the U.S., have remained the least open economies with total trade being less than 20% of their GDP. On the other hand, Panama has remained the most open economy with total trade being more than 80% of its GDP. Peru is the only country for which average openness declined from the first to the second sub-period (38.8% to 31.9%.)

According to Table 4.1, for all Latin American countries, except Mexico, the share of the U.S. in their trade declined over time. Mexico is the country for which the U.S. has kept its share of about 70%, an obvious result of the geographic proximity and the existence of trade agreements between the two countries.[76] On the other hand, for the average Latin American country, this share declined from 43.7% in the sub-period 1950-1971 to 31.7% in the sub-period 1972-2000. The reason for this decline can be explained with the help of the table in Appendix A. This table shows the five main exports and imports partners of each country in the years 1960, 1980 and 2000. According to this table, most of the Latin American countries' trade in 1960 took place with the U.S. and Europe, but as they became more open their set of trade partners expanded. By the year 2000 other Latin American countries had become main trade partners. For example, Brazil became the most important partner for Argentina, leaving the U.S. in a second

[76] Also for Venezuela, this share remained roughly the same, but at a lower value of about 46%.

place. For Paraguay and Uruguay, the trade importance of the U.S. is small in 2000 because Brazil and Argentina account for more than 40% or their imports and exports. Ecuador traded more with neighboring Colombia and Peru in 2000 than before, and Guatemala increased trade with Mexico and other Central American countries. Still, the U.S. remains an important, if not the main, trade partner for all the Latin American countries.

2.2. Statistics on the Relative Price and Relative Income Variables

Figure 4.1 shows the real exchange rate series for all Latin American countries for the period 1950-2000.[77] According to Figure 4.1, although the real exchange rate series for Argentina and Mexico seem to fluctuate around a roughly constant mean, and Peru and Uruguay seem to have a higher level at the end of the period, most countries exhibit a declining trend. The result is a depreciating real exchange rate for the average Latin American country, as indicated by the "Average" plot in Figure 4.1. Table 4.2, which shows the mean growth of the real exchange rates for the countries, confirms these observations. Most countries show a negative mean value for real exchange rate growth. However, the variability of the series is so large that the mean values are not found to be statistically different from zero. Only Panama's series is found to have a statistically negative growth rate. This is due to the outstandingly low volatility of Panama's real exchange rate series. The depreciating real exchange rate is an indication that the price level in Panama is growing at a slower pace than the price level in the U.S. This would also be true, although in a noisier way, for the average Latin American country, provided that its price level is expressed in dollar terms.

[77] Brazil has only data for 1980-2000. Chile, Ecuador and Paraguay's data for the year 1950 are missing.

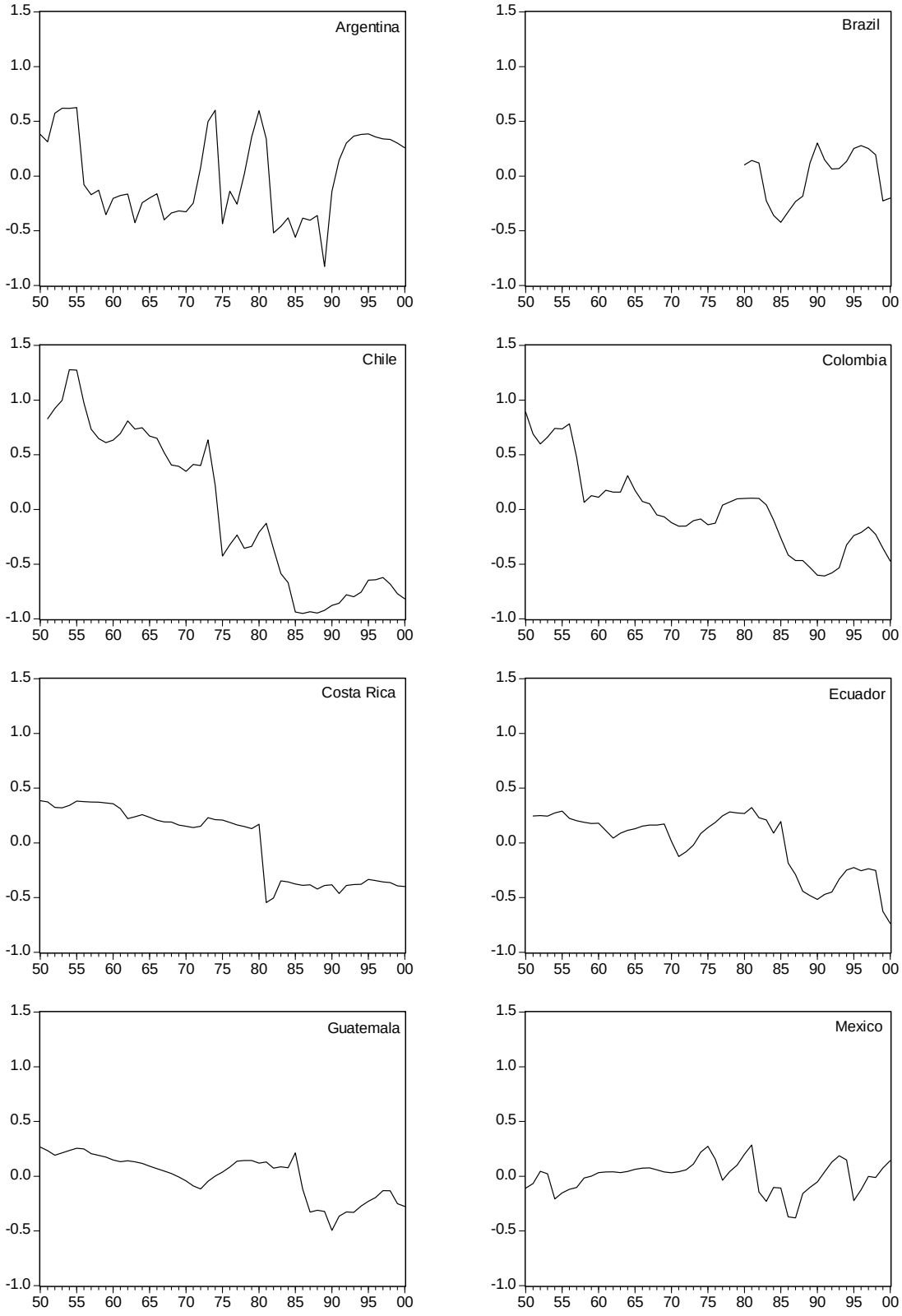
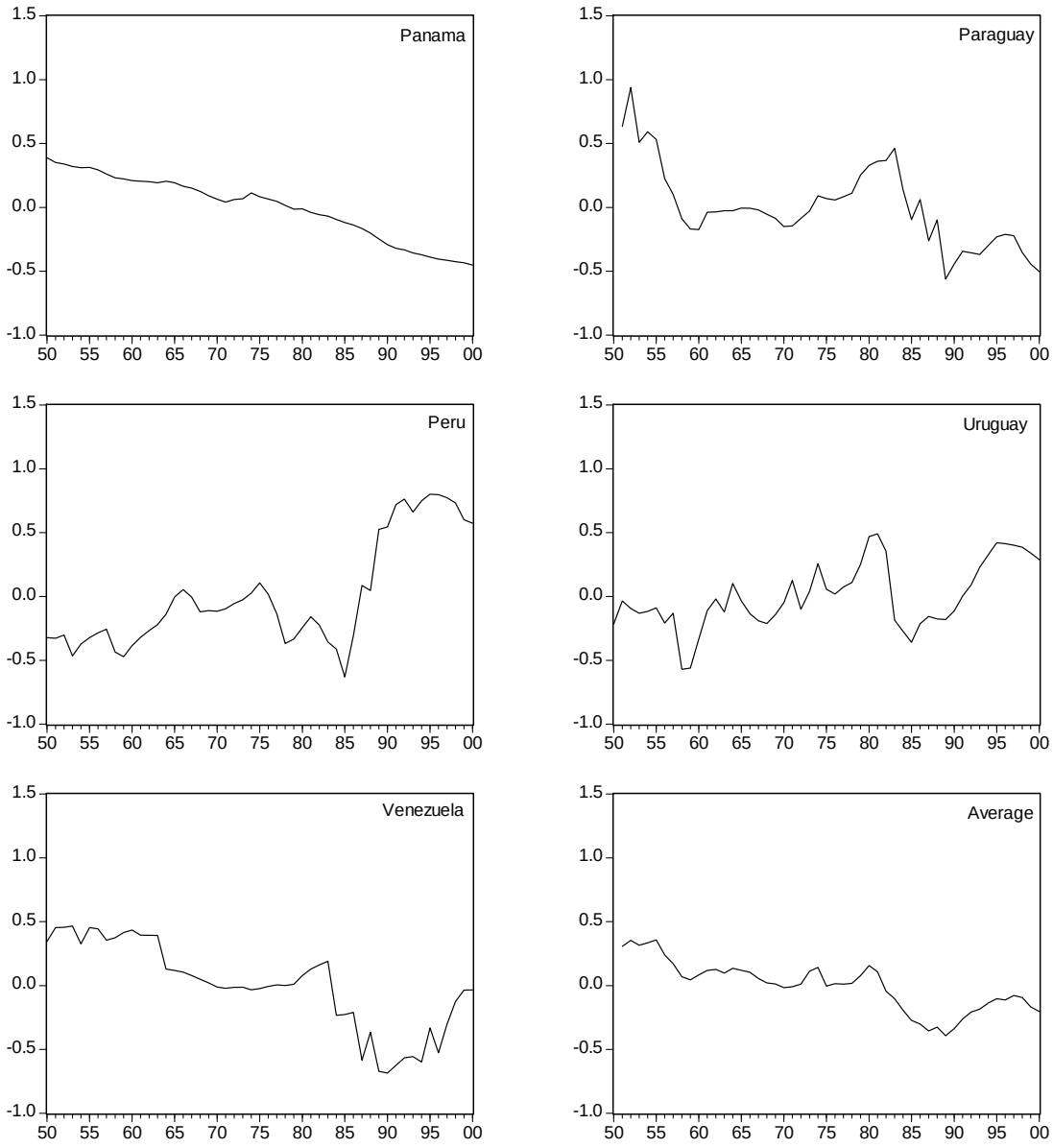


Fig. 4.1. Real Exchange Rate for 13 Latin American Countries



Note: Real exchange rates are calculated with CPI data from the IFS and nominal exchange data from the Penn World Table v6.1. Each real exchange rate series is normalized by subtracting its mean. All series are shown using the same scale. The "Average" series is a simple average of all the country series except Brazil (Excluding Panama's series from this average has no important effect.) All series are annual.

Fig. 4.1. Continued.

With respect to the second measure of relative prices, Figure 4.2 plots the common-currency relative price level series calculated with the PWT data for each Latin American

country, for the period 1950-2000. It also includes the relative real per-capita GDP series of the countries. The PWT data is complete for Brazil, but the year 1950 is still missing for Chile, Ecuador and Paraguay. The relative price measures in Figure 4.2 give roughly the same information as the real exchange rates in Figure 4.1. The "Average" relative price in Figure 4.2 tracks the "Average" real exchange rate in Figure 4.1 relatively well. In fact, a regression of the real exchange rate on the relative price in first differences results in a non-significant and practically zero intercept, a slope coefficient equal to 0.974 that is not statistically different from 1, and an $R^2 = 0.85$.

Table 4.2. Real Exchange Rate Growth Statistics and Tests for Zero Mean Growth (Period 1950-2000)

Country	N	Mean	Std	HAC StdErr	P-value
Argentina	50	-0.25%	29.37%	3.57%	0.945
Brazil	20	-1.52%	16.46%	4.26%	0.725
Chile	49	-3.36%	15.68%	2.33%	0.156
Colombia	50	-2.72%	10.81%	1.86%	0.151
Costa Rica	50	-1.57%	10.80%	1.22%	0.204
Ecuador	49	-2.00%	9.85%	1.72%	0.249
Guatemala	50	-1.09%	7.47%	1.09%	0.326
Mexico	50	0.50%	11.99%	1.38%	0.716
Panama	50	-1.68% ***	1.62%	0.30%	0.000
Paraguay	49	-2.32%	15.08%	2.02%	0.257
Peru	50	1.79%	13.32%	2.18%	0.415
Uruguay	50	1.01%	15.27%	2.19%	0.647
Venezuela	50	-0.76%	12.85%	1.67%	0.651
Average	49	-1.04%	5.73%	1.01%	0.309

Note: (***) Three asterisks indicate rejection of the null hypothesis of zero mean growth for the real exchange rate at 1% significance level. Column N shows the number of years of data used in the tests. All tests use Newey-West HAC Standard Errors because of the possible existence of serial correlation in the real exchange rate series. The "Average" row gives the results for a series calculated as the simple average of the countries' real exchange series excluding Brazil. All tests are for the full period of analysis 1950-2000, except for Brazil which has data for 1980-2000 only, and Chile, Ecuador and Paraguay, for which the data for 1950 are missing.

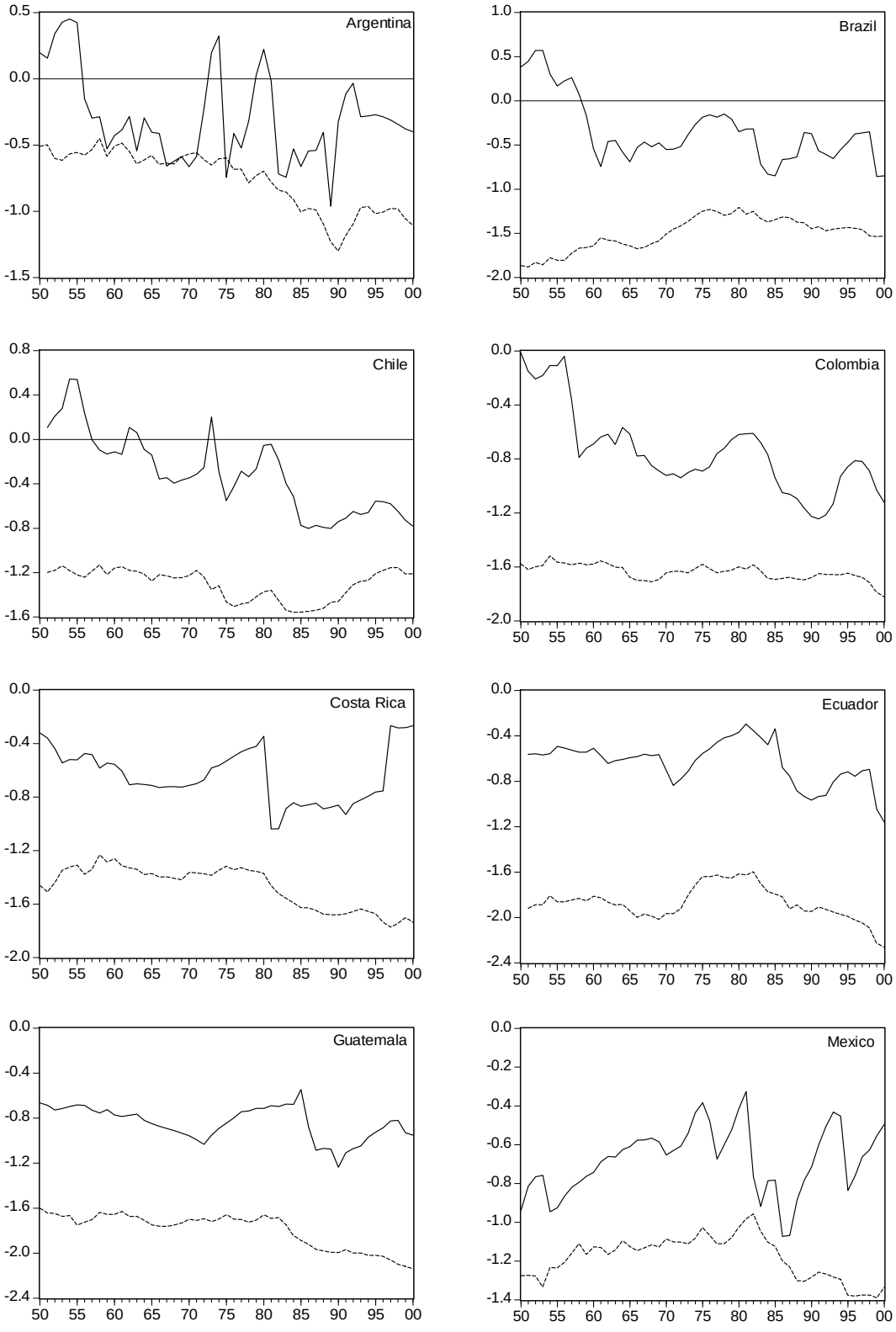


Fig. 4.2. Relative Price and Relative Real Per-Capita GDP for 13 Latin American Countries

Note: Solid line for Relative Price Level, and dotted line for Relative Real Per-Capita GDP. All series are calculated using data from the Penn World Table v6.1. The "Average" series are simple averages of all the country series (Excluding Panama's series from these averages has no important effect.) All series are annual.

Fig. 4.2. Continued.

Something important that can be observed in Figure 4.2 is that the "Average" relative price series starts the period 1950-2000 below zero (between 0 and -0.4) and

develops into a more negative number (between -0.4 and -0.8) by the end of the period. That is exactly what happens with Panama's relative price series too, although Panama's series is less volatile. The implication of this observation is that the price levels of both Panama and the average Latin American country have not only remained below that of the U.S., but also been in a diverging path from it. It is interesting that, although the "Average" relative price level shows a declining tendency throughout the whole period 1950-2000, the "Average" relative real per-capita GDP remains roughly flat during the first half of the period, and shows a clear declining tendency only during the second half.

Table 4.3 provides statistics on the relative price level, relative price level growth, relative real per-capita GDP, and relative real per-capita GDP growth for all the countries for the sub-periods 1950-1971 and 1972-2000. According to Table 4.3, both the price level and the level of real per-capita GDP of the Latin American countries have on average been below U.S. levels, and both show a long-run declining tendency. During the sub-period 1950-1971, only Venezuela has a price level above the price level of the U.S. on average. During this sub-period the cross-country average log relative price level is -0.467, which means that the Latin American price level is on average only 62.68% of the U.S. price level.[78] During the sub-period 1972-2000 the cross-country average relative price level is even lower (-0.629 in log terms, or 53.31% in ratio terms.)

During the sub-period 1950-1971 Latin American relative prices depreciate at an average rate of 1.965% per year, and during the sub-period 1972-2000 at a slower rate of only 0.265% per year. This long-run depreciation of the average relative price is accompanied by a relative flat trend of the relative real per-capita GDP of the Latin American countries during the sub-period 1950-1971, with growth of only 0.144%,

[78] The ratio value of 0.6268 is obtained by taking the exponential of the log value -0.467.

Table 4.3. Relative Price and Real Per-Capita GDP Statistics for 13 Latin American Countries

	Relative Price Level		Relative Price Growth (%)		Relative Real Per-Capita GDP Level		Relative Real Per-Capita GDP Growth (%)	
Sub-Period 1950-1971								
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Argentina	-0.234	0.384	-3.73	18.20	-0.569	0.055	-0.23	5.91
Brazil	-0.171	0.453	-4.43	15.78	-1.682	0.121	1.96	4.32
Chile	-0.035	0.283	-2.11	14.03	-1.200	0.039	0.09	4.33
Colombia	-0.528	0.316	-4.27	13.19	-1.612	0.054	-0.26	3.20
Costa Rica	-0.595	0.128	-1.81	4.50	-1.362	0.065	0.45	4.80
Ecuador	-0.582	0.075	-1.37	5.16	-1.899	0.064	-0.23	3.72
Guatemala	-0.791	0.098	-1.56	2.34	-1.691	0.047	-0.52	3.38
Mexico	-0.725	0.123	1.46	5.85	-1.171	0.070	0.83	3.89
Panama	-0.248	0.135	-2.03	2.74	-1.633	0.108	1.23	4.38
Paraguay	-0.772	0.256	-3.33	11.64	-1.667	0.088	-1.11	4.90
Peru	-0.889	0.106	-0.66	8.81	-1.320	0.057	0.95	4.58
Uruguay	-0.811	0.166	0.09	14.33	-0.804	0.164	-1.45	5.62
Venezuela	0.309	0.151	-1.80	14.01	-0.460	0.071	0.16	5.16
Average:	-0.467	0.206	-1.965	10.046	-1.313	0.077	0.144	4.478
Sub-Period 1972-2000								
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Argentina	-0.331	0.303	0.65	34.17	-0.910	0.197	-1.89	6.67
Brazil	-0.476	0.223	-1.04	15.47	-1.372	0.095	-0.27	4.26
Chile	-0.504	0.268	-1.61	16.71	-1.378	0.134	-0.10	5.58
Colombia	-0.913	0.193	-0.72	7.87	-1.660	0.053	-0.65	2.69
Costa Rica	-0.673	0.246	1.49	16.62	-1.559	0.155	-1.27	3.09
Ecuador	-0.669	0.235	-1.11	11.40	-1.851	0.186	-1.02	5.59
Guatemala	-0.883	0.167	0.14	9.67	-1.877	0.164	-1.49	3.08
Mexico	-0.644	0.197	0.47	15.38	-1.192	0.136	-0.81	4.09
Panama	-0.537	0.120	-0.65	4.03	-1.530	0.118	-0.92	6.09
Paraguay	-0.834	0.283	-0.85	14.53	-1.699	0.098	-0.72	4.84
Peru	-0.784	0.228	0.36	16.17	-1.658	0.265	-2.49	7.21
Uruguay	-0.578	0.227	0.65	16.30	-1.154	0.099	-0.79	5.75
Venezuela	-0.353	0.312	-1.22	15.44	-1.164	0.272	-3.74	4.20
Average:	-0.629	0.231	-0.265	14.904	-1.462	0.152	-1.244	4.857

Note: All the variables are relative to the U.S. and are calculated from Penn World Table v6.1 data Relative level variables are in log form and could be interpreted as the log of the ratio of the level of the variable in each country to the level of the variable in the U.S. The "Average" rows show the simple averages of the means and standard deviations across countries. Chile, Ecuador and Paraguay do not have data for year 1950.

which then becomes a declining trend during the sub-period 1972-2000 at an average rate of -1.244% per year. In both periods, no Latin American country has a level of real per-capita GDP above that of the U.S. If fact, the cross-country average relative real per-capita GDP declines, in log terms, from -1.313 in the first sub-period to -1.462 in the second sub-period.

3. Latin America and Long-Run Purchasing Power Parity

The previous section discussed how average inflation and currency depreciation more than tripled for the average Latin American country in the sub-period 1972-2000 relative to the sub-period 1950-1971, and how economic growth stagnated. Over time, the countries experienced an increase in trade openness and a decline in the share of the U.S. in their trade. Panama performed just as the average Latin American country in terms of real per-capita GDP growth, but it showed a very high degree of openness and an outstandingly low and stable inflation. In terms of the price level, both Panama and the average Latin American country show signs of divergence from the U.S. level. However, the high volatility of the countries' series prevents the reaching of any definite conclusion. The next section starts the formal comparative study of the time behavior of the first and typical measure of relative price levels between the countries and the U.S., i.e. the real exchange rate.

3.1. Long-Run Purchasing Power Parity Econometrics

In its simplest form PPP prescribes that "the general level of prices, when converted to a common currency, will be the same in every country" (Copeland, 1994, p. 71.) In the

context of CPI-based bilateral real exchange rates between the Latin American countries and the U.S. and after considering the existence of transaction costs, this definition would only require that the $q_{i,t}$ series calculated with equation (4.1) be stationarity. Temporary deviations from PPP are allowed because, in practice, disturbances in price levels are not immediately offset by changes in the nominal exchange rate (and vice-versa.) As Edison (1987) and Rogoff (1996) indicate, the consensus among economists is that PPP holds only in the long run.[79]

Abuaf and Jorion (1990) suggest that the time behavior of the real exchange rate of country *i* can be accurately modeled by a first-order autoregressive process such as:

$$q_{i,t} = q_{i,0} + \rho_i q_{i,t-1} + \varepsilon_{i,t} \tag{4.4}$$

where $q_{i,0}$ is $q_{i,t}$ at $t = 0$, ρ_i is called the first-order autocorrelation coefficient and is assumed to be a constant parameter, and $\varepsilon_{i,t}$ is a white-noise series of disturbances with zero mean. Equation (4.4) can be solved recursively going back an infinite number of time periods in the past to get:

$$q_{i,t} = \frac{q_{i,0}}{1-\rho_i} + \left(\varepsilon_{i,t} + \rho_i \varepsilon_{i,t-1} + \rho_i^{\,2} \varepsilon_{i,t-2} + \rho_i^{\,3} \varepsilon_{i,t-3} + \ldots\right) \tag{4.5}$$

The fraction on the right-hand side of equation (4.5) is the long-run equilibrium level of $q_{i,t}$ and is a constant. The terms in parentheses show the effect of the current and past disturbances, and are responsible for deviations of $q_{i,t}$ from its long-run equilibrium level. If $|\rho_i| < 1$, the long-run level is well defined becoming the expected value of $q_{i,t}$, and any deviations from this value tend to die out over time; that is, $q_{i,t}$ is mean-reverting or stationary, and long-run PPP holds. On the other hand, if $|\rho_i| \geq 1$, $q_{i,t}$ is non-stationary and long-run PPP does not hold.

[79] See also Froot and Rogoff (1995) for an excellent review on the PPP literature.

The typical test for PPP is an Augmented Dickey-Fuller (ADF) test for the presence of a unit root in the real exchange rate series, and consists of estimating the following regression:

$$\Delta q_{i,t} = \mu_i + \alpha_i q_{i,t-1} + \sum_{j=1}^{p_i} \beta_{i,j} \Delta q_{i,t-j} + \varepsilon_{i,t} \qquad (4.6)$$

For this test, Ho: $\alpha_i = 0$ indicates the presence of a unit root, and Ha: $\alpha_i < 0$ that the series is stationary. The lagged first difference terms in equation (4.6) are typically included to control for extra serial correlation in case the order of the autoregressive process is higher than 1. The optimal number of lags, p_i, is chosen using the Schwarz Information Criterion. For a process like that of equation (4.4), $\alpha_i = \rho_i - 1$, so testing for $\alpha_i = 0$ is equivalent to testing for $\rho_i = 1$, and a result of $\alpha < 0$ corresponds to $\rho < 1$. ADF tests will be done independently on each of the Latin American countries' real exchange rate series using the longest period available, i.e. the full period 1950-2000.

The main drawback of the individual ADF test is its low power, which can result in the non-rejection of the null of a unit root when, in fact, the series is stationary. Abuaf and Jorion (1990), Frankel and Rose (1996), Oh (1996), Lothian (1997), and Papell (2002) suggest a multi-series approach to increase test power. For this reason, panel unit-root tests are done on the set of Latin American bilateral real exchange rates. These are the Levin, Lin, and Chu (2002), Breitung (2000), Im, Pesaran, and Shin (2003), Maddala and Wu (1999)[80], and Hadri (2000) tests. For all tests, except the Hadri test, the null hypothesis is that all series have a unit root. For the Hadri test, the null hypothesis is that no series has a unit root, and the alternative hypothesis is that all series have a unit root.

[80] Choi (2001) proposes a similar test as the Maddala and Wu (1999) test. These tests are based on an approach by Fisher (1932).

For the Levin-Lin-Chu and Breitung tests, the alternative hypothesis is that no series has a unit root, while for the Im-Pesaran-Shin and Maddala-Wu tests the alternative hypothesis is that some series do not have a unit root. The main disadvantage of the Levin-Lin-Chu, Breitung and Hadri tests is their assumption that all the series in the panel follow exactly the same autoregressive process (i.e. that ρ_i is the same for all i.) The Im-Pesaran-Shin and Maddala-Wu tests relax this assumption allowing the series to be heterogeneous.[81]

As a robustness check, a cross-country test for long-run relative PPP can also be performed. For this, equation (4.1) is first differenced, then averaged over time, and finally re-arranged to become the following country-specific equation:

$$\overline{\Delta} q_i = \overline{\Delta}(p_i - p^*) - \overline{\Delta} e_i \tag{4.7}$$

where $\overline{\Delta} q_i = \frac{1}{N}\sum_{t=1}^{N} \Delta q_{i,t}$, $\overline{\Delta}(p_i - p^*) = \frac{1}{N}\sum_{t=1}^{N} \Delta(p_{i,t} - p^*_t)$, $\overline{\Delta} e_i = \frac{1}{N}\sum_{t=1}^{N} \Delta e_{i,t}$, and $N = 50$

because the period is 1950-2000. Averaging eliminates the index t and all time variability. According to equation (4.7), for each country i, the mean growth of its real exchange rate equals the difference between the mean inflation differential of that country with respect to the U.S. and the mean nominal exchange rate depreciation for the period of analysis. PPP requires that $\overline{\Delta} q_i$ equal zero for each country. The cross-country test for long-run relative PPP, thus, consists of estimating the following two regressions:

$$\overline{\Delta} e_i = -\mu + \beta \overline{\Delta}(p_i - p^*) + \varepsilon_i \tag{4.8}$$

$$\overline{\Delta}(p_i - p^*) = \mu' + \beta' \overline{\Delta} e_i + \varepsilon'_i \tag{4.9}$$

[81] The details of each of these tests are not given in this paper, but they can be found in the provided references.

where the intercepts, μ and μ', are to capture the mean value of $\overline{\Delta q}_i$ across countries, and ε_i and ε'_i are assumed to be white noise. If PPP holds, inflation differentials must exactly offset changes in the nominal exchange rate, and vice-versa, particularly in the long-run. This implies that the intercepts μ and μ' must be zero, and the coefficients β and β' must each equal unity. Equations (4.8) and (4.9) differ only in that the variables are transposed; they are both estimated because there is no *a-priori* reason for having either variable as the dependent variable.

3.2. Long-Run Purchasing Power Parity Test Results

Table 4.4 shows the results of the individual ADF and the panel unit-root tests for the real exchange rate series of the Latin American countries. For the ADF tests, the table also shows the value of the implied autoregressive coefficient, ρ_i. The ADF tests find that only the real exchange rate series for Argentina and Mexico are stationary. The evidence for Mexico is stronger with a rejection of a unit root at a 5% significance level. For the other countries, the evidence is against PPP. For Ecuador and Panama, the ADF test statistics are even positive (0.071 and 0.726), which points to strong non-stationarity. It is worthwhile mentioning that the cross-country average of the ρ_i coefficients in Table 4.4 would be about 0.87, very close to the consensus value of 0.85 in the PPP literature according to Rogoff (1996).

Despite their greater statistical power, the panel unit root tests shown in Table 4.4 still find evidence against PPP for the Latin American countries with respect to the U.S. When Panama is included in the panel, the Levin-Lin-Chu, Breitung, Im-Pesaran-Shin, and Maddala-Wu tests cannot reject the null hypothesis of a unit root in all real exchange

Table 4.4. Unit-Root Tests on the Real Exchange Rates (Period 1950-2000)

Part A: Individual ADF Tests

Country	Lags	ADF t-stat	ρ
Argentina	0	-2.889 *	0.709
Brazil	1	-2.343	0.630
Chile	3	-1.592	0.952
Colombia	1	-1.638	0.936
Costa Rica	0	-1.138	0.947
Ecuador	0	0.071	1.004
Guatemala	0	-1.290	0.932
Mexico	0	-3.153 **	0.652
Panama	1	0.726	1.007
Paraguay	2	-2.029	0.857
Peru	0	-0.825	0.962
Uruguay	0	-2.109	0.825
Venezuela	0	-1.508	0.921
Average:			0.872

Part B: Panel Tests Including Panama

Test	Stat	P-value	Countries	Panel N
Levin-Lin-Chu	0.925	0.823	13	612
Breitung	-0.975	0.165	13	599
Im-Pesaran-Shin	0.017	0.507	13	612
Maddala-Wu	31.515	0.210	13	612
Hadri	13.320**	0.000	13	630

Part C: Panel Tests Excluding Panama

Test	Stat	P-value	Countries	Panel N
Levin-Lin-Chu	-0.355	0.361	12	563
Breitung	-1.936**	0.026	12	551
Im-Pesaran-Shin	-0.717	0.237	12	563
Maddala-Wu	31.498	0.140	12	563
Hadri	12.570**	0.000	12	579

Note: (*)(**) One and two asterisks indicate rejection of the null hypothesis at 10% and 5% significance, respectively. The null hypothesis for all except the Hadri tests is of a unit root in all the series. All ADF test regressions include a constant, and Lags is the optimal number of lags chosen according to the Schwartz Criterion. Column ρ gives the autoregressive coefficient implied by the ADF test regression. All countries have data for 1950-2000, except Brazil with data for 1980-2000 only, and Chile, Ecuador and Paraguay without data for 1950. The panel The panel tests use unbalanced panels. P-values for the Maddala-Wu tests use an asymptotic chi-square distribution. The other panel tests assume asymptotic normality. The ADF tests use MacKinnon critical values.

rate series, and the Hadri test strongly rejects its null hypothesis that all the series are stationary in favor of the alternative hypothesis that all the series are non-stationary. When Panama is excluded, the conclusions of all the tests, except the Breitung test, remain the same. The Breitung test rejects the null of a unit root in the series, but this is probably due to the restrictive assumption of homogeneity of the series made by this test. In any case, it is obvious that the p-values of all the tests decline when Panama is excluded from the panel. Panama's real exchange rate appears to increase the non-stationarity of the series as a group.

The results of cross-country, long-run relative PPP tests corroborate the conclusions above that PPP does not hold for the group of Latin American countries. Table 4.5 shows the results of estimating equations (4.8) and (4.9) for sub-periods 1950-1971, 1972-2000, and for the total period 1950-2000. In Table 4.5, the intercepts μ and μ' are statistically significantly different from zero in five of the six estimated regressions. The sign of the intercepts imply a negative cross-country mean growth rate of the bilateral real exchange. That is, that there is an overall tendency for the average Latin American real exchange rate to depreciate over time with respect to the U.S. For example, the estimate for μ for the total period 1950-2000 suggests an average real exchange rate depreciation of about 1.80% per year, or a total depreciation of about 90% for the total period. The slope coefficients β and β' are found to be statistically different from 1 in the regressions for the sub-period 1972-2000. However, the differences of these coefficients from 1 are very small, and found to be non-significant in the other regressions.

The result of a depreciating real exchange rate for the average Latin American country can be interpreted as a tendency for the inflation differential between the average

Latin American country and the U.S. to be smaller than the rate of depreciation of the nominal exchange rate. For countries that could devalue, this means that they have been successful in translating nominal devaluations to the real exchange rate and that their price level, once translated to dollars, could not get to grow as fast as the U.S. price level no matter how high their domestic inflation was. For a country like Panama, which cannot devalue, this implies an inflation rate lower than that of the U.S., as has actually been the case. In other words, for both the average Latin American country and Panama, the implication of the result is that inflation in dollar terms has been on average lower than U.S. inflation.

Table 4.5. Tests for Long-Run Relative PPP for 12 Latin American Countries

Dependent Variable: Mean Nominal Exchange Rate Depreciation

Period	μ	β	R^2	P-value for Test Ho: $\beta = 1$
1950-1971	-1.591 *	0.995 ***	0.963	0.932
	(0.749)	(0.062)		
1972-2000	-1.852 **	0.956 ***	0.997	0.033
	(0.642)	(0.018)		
1950-2000	-1.796 **	0.960 ***	0.993	0.144
	(0.639)	(0.026)		

Dependent Variable: Mean Inflation Differential

Period	μ'	β'	R^2	P-value Test $\beta' = 1$
1950-1971	-1.263	0.968 ***	0.963	0.607
	(0.796)	(0.060)		
1972-2000	-1.837 **	1.043 ***	0.997	0.053
	(0.697)	(0.019)		
1950-2000	-1.727 **	1.035 ***	0.993	0.234
	(0.700)	(0.028)		

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance at 10%, 5% and 1%, respectively. In parentheses are the standard errors of the estimates. The last column shows the p-value for a test with Ho: $\beta = 1$, and Ha: $\beta \neq 1$. All tests are cross-sectional with N=12, including Panama but excluding Brazil. The exclusion of Panama produces very minor changes.

The depreciating real exchange rate result obtained above is, of course, an average, long-run result for the cross-section of countries, obtained by ignoring time variability. According to Table 4.2, all countries except Mexico, Peru and Uruguay do, in fact, have a negative mean growth of the real exchange rate. However, only Panama's mean is statistically negative. This result is due to the outstandingly low variability of Panama's series. The results of the PPP tests shown in this section suggest that the real exchange rate series of the average Latin American country also has a statistically significant tendency to depreciate, but that is a long-run tendency. In the short run, the average Latin American real exchange rate is subject to wide variability. On the other hand, for Panama, the short-run behavior of the real exchange rate is very consistent with that of the long-run.

It is important to notice that the mean annual rate of depreciation of the real exchange rate for dollarized Panama (1.68% in Table 4.2) is very close to that estimated for the average non-dollarized Latin American country (between 1.7% and 1.8% in Table 4.5 for the regressions' intercept for the period 1950-2000.) That is, the long-run result on the relative price level seems to be the same no matter what the exchange rate system is. However, according to this study, while the journey has been smooth for Panama, it has been very bumpy for the average Latin American country.

3.3. Long-Run PPP, Country Characteristics, and Test Limitations

The results for long-run PPP do not seem to depend on some economic characteristics of the countries. For example, Mexico is much more open to trade than Argentina, and the share of the U.S. in Mexico's trade is much greater than in

Argentina's. However, both countries show evidence in favor of PPP. As is Mexico, Panama is very influenced by the U.S. through trade, but Panama is the country that shows the clearest evidence against PPP. With respect to the exchange rate regime, Panama is dollarized and the others are not. Despite this, the real exchange rate series of both Panama and the average Latin American country have depreciated at a similar rate over the period 1950-2000. Inflation performance does not seem to matter either for the long-run behavior of the real exchange rate. The mean inflation differential for both Uruguay and Chile relative to the U.S. for the period 1950-2000 is about 30%, but while Uruguay shows an appreciating real exchange rate, Chile shows a strongly depreciating real exchange rate.

This study's analysis on PPP has its limitations. First, the results may change if the period of analysis is extended or modified. The estimated average autoregressive coefficient for the sample of Latin American countries, $\rho = 0.87$, is close to the consensus value of 0.85 in the literature, but several countries exhibit values over 0.90. ADF tests that do not detect stationarity with the length of this study's time series may detect it with longer time series. However, longer series may also change the results in the opposite direction. For example, this study's stationarity result for Argentina's real exchange rate for the period 1950-2000 could change to non-stationarity if the 1913-1988 data mentioned in Froot and Rogoff (1995) are used.[82] In any case, if it is assumed that the nature of the series' behavior has not changed over time, this study's use of panel data methods must have dealt with this issue relatively well.

[82] Froot and Rogoff indicate that during the period 1913-1988, Argentina's real exchange rate depreciated at an average annual rate of about 1%. With this depreciation rate, non-stationarity is more plausible than with this study's estimated depreciation rate of just 0.25% for the period 1950-2000 (See Table 4.2.)

Second, some authors indicate that the right-hand side variables in equation (4.1) may indeed be cointegrated but with coefficients that are different from 1 implying that a "modified" real exchange rate would be stationary. This issue has been ignored in this study not only because, as Froot and Rogoff (1995) mention based on Banerjee, Dolado, Hendry, and Smith (1986) that cointegrating regressions in finite samples can lead to substantial bias, but also because the reasons for the coefficients to differ from 1 would be the reasons for which "standard" PPP fails to hold.

After concluding that the average Latin American country's real exchange rate does not satisfy PPP, it is necessary to provide some explanation for why this happens. Nelson and Plosser (1982) indicate that the apparent trend observed in some time series may not be deterministic but rather is stochastic resulting from real shocks with permanent rather than transitory effects. In fact, Edison (1987) in a study of the dollar/pound exchange rate for the period 1890-1978 calls the implications of PPP models such as that of equation (4.1) "naive" because relevant variables such as relative cash balances and the relative level of output of the economy are being overlooked. According to Edison, although there are forces that push economies towards PPP equilibrium, there are also forces that cause permanent deviations from PPP. The explanations provided by the author are in line with the Balassa-Samuelson hypothesis, which is examined in the next section.

4. Relative Price Level Divergence in the Long Run

The violations to PPP found in the previous sections above for the average Latin American country, and particularly for Panama, may be the result of real shocks with permanent effects. As a consequence, the real exchange rate shows a depreciating trend,

diverging from any constant long run equilibrium level. A straightforward explanation of the mechanism that brings about this result starts by assuming that the CPIs in country *i* (p_i) and the U.S. (p^*) are calculated as Cobb-Douglas functions of the price levels of two types of commodities, non-tradables (*N*) and tradables (*T*). That is, in log form and ignoring the time index:

$$p_i = (1-\theta_i)p_{i,T} + \theta_i p_{i,N} \tag{4.10}$$

$$p^* = (1-\theta^*)p_T^* + \theta^* p_N^* \tag{4.11}$$

where θ_i and θ^* are the weights between zero and 1 given to the price level of non-tradables in country *i* and the U.S., respectively. Equations (4.10) and (4.11) can be substituted into equation (4.1). If in addition, PPP is assumed to hold for tradables (but not for non-tradables), equation (4.1) can be expressed as:

$$q_i = (\theta^* - \theta_i)p_{i,T} + \theta_i p_{i,N} - \theta^* e_i - \theta^* p_N^* \tag{4.12}$$

which after further assuming that $\theta_i = \theta^*$, reduces to:

$$q_i = \theta_i (p_{i,N} - e_i - p_N^*) \tag{4.13}$$

Equation (4.13) implies that real exchange rate divergence is due to deviations between the price of the non-tradable commodities between country *i* and the U.S., once expressed in a common currency.[83] A reason for these deviations can be clearly appreciated if equation (4.13) is expressed in growth (i.e. first-difference) form after substituting $e_i = p_{i,T} - p_T^*$ (which, as assumed above, indicates that PPP holds for tradables):

$$\Delta q_i = \theta_i [(\Delta p_{i,N} - \Delta p_{i,T}) - (\Delta p_N^* - \Delta p_T^*)] \tag{4.14}$$

[83] The price of tradables, for which PPP is assumed to hold, will also have a diverging influence on the real exchange rate if $\theta_i \neq \theta^*$. The nature of this influence will depend on how different the two weights are. See equation (4.12).

According to equation (4.14), if the growth rates of the relative price of non-tradables versus tradables in country *i* and the U.S. are different, the growth rate of the real exchange rate will be non-zero, i.e. the real exchange rate will diverge from a constant level.

Balassa (1964, 1973) and Samuelson (1964) argue that cross-country differences in the growth rate of the relative price of non-tradables versus tradables can arise from cross-country differences in productivity growth. If productivity growth is faster in the U.S. than in country *i*, the value of the term $\Delta p_N^* - \Delta p_T^*$ will be greater than the value of the term $\Delta p_{i,N} - \Delta p_{i,T}$ in equation (4.14), causing Δq_i to be negative.[84] This is because productivity growth is generally reflected as improved labor efficiency in the production of tradables rather than non-tradables. As a result, the growth of the price of tradables slows down relative to the growth of the price of non-tradables. The difference in price growth rates would be more pronounced in countries with slower productivity growth than in the U.S.[85]

To better understand the relationship between cross-country differential productivity and real exchange divergence, a simple two-country, supply-side model can be used.[86] The model assumes that the two types of commodities are each produced using constant-returns-to-scale production functions with labor as the only factor. Labor is assumed to be in fixed supply in both country *i* and the U.S., and to be perfectly mobile between the tradables and non-tradables sector within each country but not across countries. This

[84] This was the result found for both Panama and the average Latin American country in the previous sections. For both, the mean growth rate of the real exchange rate is negative for the period 1950-2000 according to Table 4.2.
[85] This is in line with the explanation provided in McCallum (1996a, p. 33-34.)
[86] This model is presented in the Appendix of Chapter 5 of De Grauwe (1996), and is used by Hsieh (1982) to provide time-series evidence in favor of the Balassa-Samuelson hypothesis.

guarantees that equilibrium wages are the same across sectors in a country but not necessarily across countries. Under perfect competition, workers will be paid the value of their marginal labor productivity. In equilibrium, the wage in country *i* and the U.S., in log terms, will be:

$$w_i = p_{i,T} + a_{i,T} = p_{i,N} + a_{i,N} \tag{4.15}$$

$$w^* = p_T^* + a_T^* = p_N^* + a_N^* \tag{4.16}$$

where $a_{i,T}$ and $a_{i,N}$, are the productivity of production in the tradables and the non-tradables sector, respectively, in country *i*; a_T* and a_N* are the corresponding U.S. productivity variables. Solving for $p_{i,N}$ in terms of $p_{i,T}$, $a_{i,T}$ and $a_{i,N}$ using equation (4.15), and for p_N* in terms of p_T*, a_T* and a_N* using equation (4.16); then plugging $p_{i,N}$ and p_N* into the price index equations (4.10) and (4.11), respectively; and then plugging these into equation (4.1) and rearranging, the following equation is obtained:

$$q_i = (p_{i,T} - e_i - p_T^*) - (\theta_i a_{i,N} - \theta^* a_N^*) + (\theta_i a_{i,T} - \theta^* a_T^*) \tag{4.17}$$

If PPP holds for the tradable commodities, the first term in parentheses becomes zero. If in addition the productivity of production in the non-tradables sector and the price index weights are the same in both countries (i.e. $a_{i,N} = a_N$* and $\theta_i = \theta$*), the second term in parentheses becomes zero. Under these assumptions, equation (4.17) can be simplified to:

$$q_i = \theta_i (a_{i,T} - a_T^*) \tag{4.18}$$

or in growth form as:

$$\Delta q_i = \theta_i (\Delta a_{i,T} - \Delta a_T^*) \tag{4.19}$$

which indicates that real exchange rate divergence is the result of productivity differentials in the production of the tradable commodity between country *i* and the U.S. According to equations (4.18) and (4.19), the observed long-run depreciation of the bilateral real exchange rate for the average Latin American county, and in particular for Panama, would be the result of their level of productivity not growing as fast as that of the U.S.

4.1. Alternative Explanations for Price Level Divergence

Among the possible explanations for price level divergence between countries, the Balassa-Samuelson productivity differential hypothesis remains robust. In an effort to explain the divergence in the price of non-tradables across some members of the European Monetary System (EMS), Froot and Rogoff (1991) present a model in which labor has diminishing rather than constant returns. In addition, they introduce government expenditure as a possible determinant of relative price levels. The authors find that the relative price of non-tradables to tradables can still be expressed as a function of the relative labor productivities between the two sectors. Their results provide more support for the productivity differential hypothesis than for the government expenditure effect. Dornbusch (1991) and Kiyotaki (1991) in their comments on the work of Froot and Rogoff (1991) argue that any factor affecting the between-country relative price must have inter-sectoral productivity differentials as the underlying force. Froot and Rogoff (1995), after adding perfectly-mobile capital as a second factor of production, confirm that productivity differentials are indeed relevant, although they also show that even if they do not exist, relative prices can still diverge depending on the relative intensiveness

in the use of labor in production of non-tradable versus tradable commodities. The Froot and Rogoff (1995) model is used by De Gregorio, Giovannini, and Wolf (1994) to present evidence in favor of the productivity-differential hypothesis in a study based on 1970-1985 sectoral data for OECD countries. Chinn (1997) also uses the Froot and Rogoff (1995) model when presenting a 1970-1991 OECD panel-data analysis comparing the performance of alternative models of real exchange rate determination. The author finds that, for the long run, productivity differentials are the determinant factor, but for the short run government spending is more relevant.

Other authors, such as Kravis and Lipsey (1983) and Bhagwati (1984) explain cross-country price level differences using differences in endowments of factors of production. The authors argue that non-tradable commodities are cheaper in poor countries because wages are lower there. This is due to the countries' low marginal productivity of labor, which is in turn a result of their low capital-to-labor ratio.[87] The implications of the Kravis-Lipsey-Bhagwati view are similar those of the Balassa-Samuelson hypothesis but only in a static sense. Only the latter can provide a satisfactory explanation for the dynamics of the relative price level over time. For example, the former view cannot explain why within a country the prices of service-intensive commodities (typically identified as non-tradable) have tended to increase over time even though productivity growth in the services sector has been limited.[88]

Finally, some authors argue that the role of tradables in the determination of price level divergence across countries has been largely neglected. Particularly, they suggest that the assumption that PPP holds for tradables made by the supporters of the Balassa-

[87] See Krugman and Obstfeld (2003), and Froot and Rogoff (1995) for more on this issue.
[88] Froot and Rogoff (1995) call this a "Baumol-Bowen" effect (see Baumol and Bowen, 1966).

Samuelson hypothesis may not be that accurate in the real world. The idea is that oligopolistic suppliers of tradables have market power and so are able to price discriminate across different regions or different countries. Froot and Rogoff (1995) provide an excellent review on the "pricing to market" literature that supports this view.

4.2. Long-Run Relative Price Level Movements: The Econometrics

The implication of the Balassa-Samuelson hypothesis is that, because higher productivity growth leads to both an appreciating real exchange rate and better standards of living, countries with higher levels of per-capita income must have higher average price levels. To formally test this implication, the following regression model is estimated:

$$q'_{i,t} = \mu_i + \delta_i \, y'_{i,t} + \varepsilon_{i,t} \qquad (4.20)$$

Variables $q'_{i,t}$ and $y'_{i,t}$ were defined in section 2, with equations (4.2) and (4.3) as the common-currency relative price level and relative real per-capita GDP level between country i and the U.S. at time t, respectively, both calculated with data from the PWT. Equation (4.20) can also be interpreted as an estimation of the relationship presented by equation (4.18) with relative real per-capita GDP, or relative income, being used as a proxy for relative productivity between country i and the U.S. (i.e. for the term $a_{i,T} - a_T^*$.) According to this relationship, coefficient μ_i is expected to be roughly zero, and δ_i to be positive and between zero and 1 because it would be estimating θ_i from equation (4.18).

The estimation of equation (4.20) is first done using period-specific, cross-section averages of the variables after assuming a common intercept and slope coefficient across countries (that is, with $\mu_i = \mu$ and $\delta_i = \delta$ for all i.) Through a cross-section analysis it is

possible to determine whether Panama's price level relative to that of the U.S. is higher than expected for the average Latin American country after controlling for the Balassa-Samuelson income effect. With Panama's being dollarized for a long time, higher economic integration with the U.S. may have contributed to it having a price level that is higher than expected for its income level. The analysis, thus, consists of doing cross-section estimations of equation (4.20) for different time periods and evaluating the influence of Panama's observation on the estimation.

To evaluate the influence of Panama's observation on the cross-section estimations of equation (4.20), four regression diagnostic criteria found in Belsley, Kuh, and Welsch (1980) are used.[89] They are: the studentized residual, *rstudent* (an adjusted z-score); a measure of the change in the determinant of the covariance matrix of the estimates, *covratio*; a measure of the change in the predicted value of the observation, *dffits*; and a measure of the change in each estimated coefficient, *dfbeta*. The criteria are calculated by comparing the estimation results when Panama's observation is excluded with those when it is included. The observation would be too influential if the absolute values of the criteria are above certain size-adjusted upper limits. The upper limit for *rstudent* is 2, for *covratio* is $1+3p/n$, for *dffits* is $2\sqrt{p/n}$, and for each *dfbeta* is $2/\sqrt{n}$; where p is the number of parameters estimated (in this case 2: the intercept and the relative income coefficient), and n is the sample size (in this case 13 countries.)

To examine the robustness of the results obtained through the cross-section estimations of equation (4.20), the relationship between relative price and relative income is also investigated using time-series regressions for the sub-periods 1950-1971 and

[89] The reference and the names for the criteria are borrowed from SAS Institute Inc. (1999).

1972-2000. Considering the short length of the series available, the results of this analysis have to be regarded as tentative. First, equation (4.20) is estimated individually for each country using the Ordinary Least Squares (OLS) method, and the residual series obtained from these regressions are tested for stationarity using the usual unit-root ADF test. If for a given country, the residuals are found to be stationary, the series $q'_{i,t}$ and $y'_{i,t}$ can be considered cointegrated, i.e. not drifting too far apart from each other in the long-run.[90] According to Johnson (1990), Engle and Granger (1987), and Stock (1987), if $q'_{i,t}$ and $y'_{i,t}$ are cointegrated, the OLS estimation of equation (4.20) gives consistent estimates of the coefficients. However, according to Banerjee et al. (1986) and Stock (1987), the coefficients will be biased in small samples, particularly if the fit of the model is poor. This is obviously a problem with the available series that is ignored in this study.

Second, under the assumption of cointegration, a simple Error Correction Model (ECM) suggested by Engle and Granger (1987) is estimated. The purpose of this estimation is mainly to corroborate the existence of cointegration between $q'_{i,t}$ and $y'_{i,t}$ by confirming that the coefficient of the lagged Error Correction term is negative and statistically significant. Each country has its own Error Correction term which is the residual series obtained above through the estimation of equation (4.20) for each country individually. The ECM estimation consists of regressing the first difference of the relative price series, $\Delta q'_{i,t}$, on a constant, the first difference of the relative income series, $\Delta y'_{i,t}$, and the one-period lagged OLS residual, $U_{i,t-1}$.[91] To deal with the low power of the tests due to the short length of the series, the ECM is estimated with the 13 countries as a

[90] See Ramanathan (1998, p. 540) for the details about testing for cointegration using the ADF test.
[91] This two-step estimation method for an ECM is shown to be consistent and efficient by Engle and Granger (1987). Still these are asymptotic properties which may not hold in small samples. See also Johnson (1990).

panel. The estimation is done, first assuming common intercept and slope coefficients across countries, and then relaxing this assumption. The country-specific results may be used to get an idea of the nature of the short-term relationship between the relative price and income variables for each country. To control for possible cross-country heteroscedasticity and contemporaneous correlations, the estimation uses the Seemingly Unrelated Regression (SUR) method.

4.3. Results for the Long-Run Relative Price Movements Analysis

Table 4.6 shows the results of the cross-section estimations of equation (4.20) and the values of Panama's influence criteria for five sub-periods of 10 years in length, for the sub-periods 1950-1971 and 1972-2000, and for the total period 1950-2000. The results suggest the existence of a Balassa-Samuelson effect for the Latin American countries that is more evident for the later years. For the sub-period 1950-1971, the estimated relative income coefficient is positive and between zero and 1 as expected (δ = 0.326), but it is not statistically significant. The coefficient changes to 0.400, and becomes statistically significant, although only at 10% level, when the estimation is restricted to the last ten years of this sub-period. For sub-period 1972-2000, the evidence of a Balassa-Samuelson effect is stronger. The estimated relative income coefficient is positive, between zero and 1 (δ = 0.512), and highly significant. In addition, the fit of the model is much better than for any other sub-period (R^2 = 0.639.) With respect to the intercept μ, it is not statistically different from zero for any of the sub-periods, just as expected for equation (4.20). The results for the full period 1950-2000 are similar to

Table 4.6. Cross-Section Regressions of Average Relative Price Level on Average Relative Real Per-Capita GDP for 13 Latin American Countries

Period	μ	δ	R^2
1950-1960	-0.058	0.223	0.059
	(0.371)	(0.268)	
1961-1970	-0.048	0.400 *	0.302
	(0.254)	(0.183)	
1971-1980	0.158	0.506 **	0.452
	(0.230)	(0.168)	
1981-1990	-0.222	0.319 *	0.249
	(0.250)	(0.167)	
1991-2000	0.105	0.503 ***	0.513
	(0.237)	(0.148)	
1950-1971	-0.040	0.326	0.169
	(0.301)	(0.217)	
1972-2000	0.119	0.512 ***	0.639
	(0.173)	(0.116)	
1950-2000	0.040	0.429 **	0.372
	(0.242)	(0.168)	

Influence Criteria for Panama's Observation

Period	rstudent	covratio	dffits	dfbeta μ	dfbeta δ
1950-1960	0.72	1.27	0.29	-0.12	-0.20
1961-1970	1.23	1.01	0.41	-0.07	-0.19
1971-1980	0.86	1.16	0.28	-0.06	-0.13
1981-1990	1.30	0.96	0.38	0.07	0.01
1991-2000	0.21	1.30	0.06	0.00	-0.01
1950-1971	1.00	1.13	0.36	-0.11	-0.21
1972-2000	1.13	1.04	0.34	-0.02	-0.08
1950-2000	1.16	1.04	0.38	-0.09	-0.18
Upper Limit	2.00	1.46	0.78	0.55	0.55

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance of the estimate at 10%, 5% and 1%, respectively. In parentheses are the standard errors of the estimates. For all regressions N = 13; one observation for each Latin American country in the sample. Influence criteria for Panama and their size-adjusted upper limits are calculated according to Belsley, Kuh, and Welsch (1980).

those for the sub-period 1972-2000, although somewhat weakened by the use of the earlier years.[92]

With respect to the influence of Panama's observation on the estimations, Table 4.6 shows that in all periods, the Belsley-Kuh-Welsch criteria values for Panama are below the allowed upper limits. This means that Panama's influence on the estimations is not greater than that of any of the other 12 countries in the sample. The implication of this result is that if the Balassa-Samuelson effect, as estimated with equation (4.20), accurately reflects the relationship between the relative price and the relative income of the average Latin American country, Panama's price level is not higher (or lower) than can be expected for a country with its income level.

Figure 4.3 shows plots of the mean relative price level versus the mean real per-capita GDP level of the 13 Latin American countries in the sample for sub-periods 1950-1971 and 1972-2000. The plots clearly reflect the results in Table 4.6 that a Balassa-Samuelson effect is more evident in the latter period. In addition, in neither of these two plots does Panama seem to be an influential observation. Panama, together with Brazil, Chile and Venezuela, seem to have too high a price level for their income levels in the sub-period 1950-1971, but that is only the result of a practically non-existent relationship for the countries in that period. It is worthwhile mentioning that in the sub-period 1972-2000, Panama is the country with the median level of relative real per-capita GDP, a fairly good position considering the country's size and lack of natural resources. A question for further research would be whether dollarization has been an important factor for Panama's reaching this level of income.

[92] These results are comparable to those presented by Rogoff (1996). The author runs a similar regression as equation (4.20) using a sample of 100 countries for 1990. His estimated relative income coefficient is a significant 0.366, and $R^2 = 0.42$.

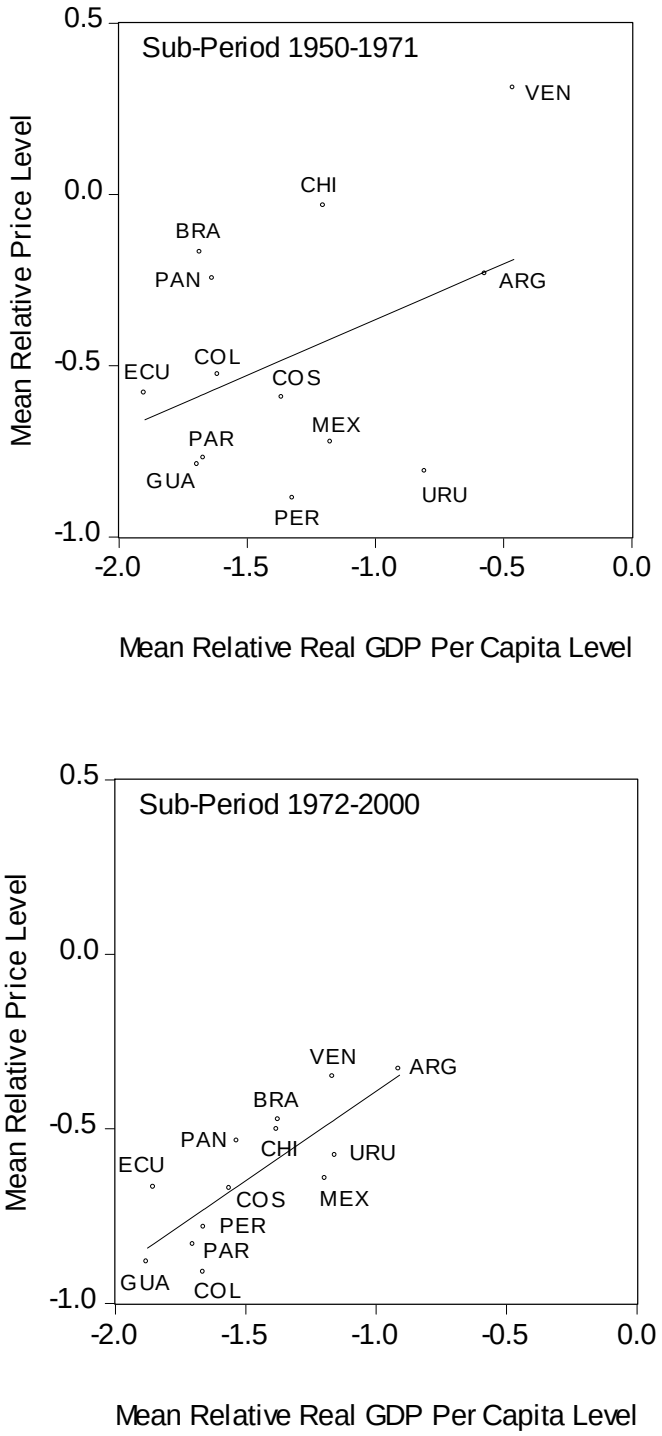


Fig. 4.3. Relationship between Relative Price Level and Relative Real Per-Capita GDP

Figure 4.3 and the results in Table 4.6 illustrate what can be considered *convergence* over time to a relationship where income is a clear long-run determinant of the price level of the countries. Figure 4.3 shows how the very scattered group of countries in 1950-1971 shifted to become a more compact relationship in 1972-2000. For sub-period 1972-2000, a 1% increase in relative income is expected to produce an increase in the relative price of 0.512%. A statement like this is not possible for the sub-period 1950-1971. In fact, this convergence behavior can explain the atypical positive mean growth found for the real exchange rates of Mexico, Peru and Uruguay as shown in Table 4.2. These countries' relative price levels were so depressed initially that they had to increase to become consistent with the more evident price-income relationship observed in the later years.[93] This convergence-like behavior could be the result of the greater integration of the Latin American countries to the world markets during the last decades. Sub-period 1950-1971 overlaps with the Bretton-Woods period of fixed exchange rates while sub-period 1972-2000 coincides with the emergence of more flexible exchange rate systems. In addition, during the latter sub-period the economies become more open to trade and have more trade partners.

With respect to the robustness checks, Table 4.7 shows for each country the results of the time series OLS regressions of relative price level on relative income level, according to equation (4.20), and the results of ADF unit-root tests on these regressions' residual series for each sub-period. Table 4.7 shows the results for each country individually and for the countries pooled in a panel.

[93] For example, it can be seen in Table 4.3 that the mean relative price levels of Mexico, Peru and Uruguay for the sub-period 1950-1971 (-0.725, -0.889 and -0.811, respectively) are too low compared to the cross-country average price level (-0.467). These countries' relative price levels in the sub-period 1972-2000 are more consistent with not only the cross-country average, but also their specific income level.

Table 4.7. Time Series Ordinary Least Squares Regressions of Relative Price on Relative Real Per-Capita GDP, and ADF Unit-Root Tests on their Residuals

	Sub-Period 1950-1971					Sub-Period 1972-2000				
Country	μ	δ	R^2	DW	Residual ADF Test	μ	δ	R^2	DW	Residual ADF Test
Argentina	0.532	1.346	0.037	0.231	0.021 **	0.102	0.476	0.095	1.341	0.001 ***
	(0.882)	(1.545)				(0.262)	(0.282)			
Brazil	-5.731	-3.305	0.781	0.686	0.008 ***	1.216	1.234	0.278	0.632	0.032 **
	(0.660)	(0.392)				(0.526)	(0.383)			
Chile	2.555	2.158	0.088	0.452	0.147	-0.450	0.039	0.000	0.389	0.006 ***
	(1.916)	(1.596)				(0.533)	(0.385)			
Colombia	4.916	3.379	0.335	0.370	0.084 *	2.247	1.903	0.271	0.228	0.038 **
	(1.715)	(1.064)				(0.998)	(0.601)			
Costa Rica	-1.169	-0.421	0.046	0.107	0.072 *	-0.208	0.298	0.035	0.466	0.138
	(0.589)	(0.432)				(0.470)	(0.300)			
Ecuador	0.361	0.496	0.181	0.727	0.024 **	1.312	1.070	0.717	0.629	0.027 **
	(0.461)	(0.243)				(0.241)	(0.129)			
Guatemala	1.110	1.124	0.294	0.350	0.472	0.083	0.514	0.256	0.441	0.023 **
	(0.658)	(0.389)				(0.318)	(0.169)			
Mexico	0.626	1.154	0.438	0.893	0.013 **	-0.269	0.314	0.047	0.605	0.038 **
	(0.343)	(0.292)				(0.326)	(0.272)			
Panama	-2.138	-1.157	0.850	0.930	0.002 ***	0.601	0.744	0.530	0.598	0.030 **
	(0.178)	(0.109)				(0.207)	(0.135)			
Paraguay	1.333	1.263	0.188	0.287	0.000 ***	1.995	1.665	0.330	0.366	0.095 *
	(1.004)	(0.601)				(0.777)	(0.457)			
Peru	-1.543	-0.495	0.070	0.851	0.003 ***	-1.410	-0.378	0.192	0.717	0.019 **
	(0.532)	(0.403)				(0.250)	(0.149)			
Uruguay	-0.739	0.090	0.008	0.703	0.042 **	1.085	1.441	0.396	0.603	0.002 ***
	(0.185)	(0.226)				(0.397)	(0.343)			
Venezuela	0.350	0.088	0.002	0.840	0.029 **	0.543	0.770	0.449	0.406	0.016 **
	(0.220)	(0.473)				(0.196)	(0.164)			
Pooled	-0.071	0.303	0.931	1.147 ^{w}		0.101	0.498	0.975	1.202 ^{w}	
	(0.013)	(0.009)	0.106	0.083 ^{uw}		(0.035)	(0.021)	0.313	0.416 ^{uw}	

Note: Columns "Residual ADF Test" shows the p-value of an ADF unit-root test done on the residual series of each country's OLS regression. In all cases, the test regression has no constant term, and the optimal number of lags is selected using the Schwarz Criterion. The p-values are obtained using the appropriate MacKinnon distributions (one-side values.) For these tests, one, two and three asterisks indicate the rejection of the unit-root null hypothesis at 10%, 5% and 1%, respectively. The Pooled results are obtained with the 13 countries as a panel, assuming common coefficients, and using the Seemingly Unrelated Regression (SUR) method. The R^2 and the Durbin Watson (DW) statistics are reported in both weighted (^{w}) and unweighted (^{uw}) form. The results are practically unchanged when Panama is excluded from the panels. The panel for the sub-period 1950-1971 is unbalanced because Chile, Ecuador and Paraguay do not have data for 1950. Standard errors for the regression coefficients are reported in parentheses, but they are not reliable for testing because the series in the regressions are non-stationary.

In Table 4.7, the low values for the Durbin-Watson (DW) statistic in all the regressions (most of them less than 1) are a sign of the non-stationarity of the relative

price and income level series used in equation (4.20).[94] Despite this, for practically all countries and in both sub-periods, the residuals are found to be stationary. Only Chile and Guatemala in the sub-period 1950-1971, and Costa Rica in the sub-period 1972-2000 appear to have a unit root in their residual series. When the null hypothesis of a unit root is rejected, most of the time is at 5% or 1% significance level, and just a few times at 10%. Therefore, the results of the ADF unit-root tests in Table 4.7 seem to support that the relative price and relative income levels of the countries are cointegrated in each sub-period. This conclusion would hold pretty well for the average Latin American country.[95]

With respect to the coefficients μ and δ of equation (4.20), the time-series results shown in Table 4.7 corroborate the cross-section results shown in Table 4.6. The "pooled" estimates of the relative income coefficient, δ, in Table 4.7 are very similar to those in Table 4.6 (compare 0.303 to 0.326, and 0.498 to 0.512 for the periods 1950-1971 and 1972-2000, respectively.) The estimated intercepts are also similar in the two tables. In addition, consistent with the cross-section results, the unweighted R^2 of the pooled regression in Table 4.7 is better for the second sub-period than for the first (compare 0.31 to 0.11.) The country-specific results suggest that the reason for the poorer fit in the first sub-period is a greater heterogeneity of coefficients across countries. The country-specific estimates of μ and δ in Table 4.7 range from -5.731 to 4.916 and from -3.305 to 3.379, respectively, for the first sub-period. For the second sub-period the ranges are much narrower; from -1.410 to 2.247 and from -0.378 to 1.903 for μ and δ, respectively. It can also be concluded, based on the higher values of the weighted R^2 of the pooled

[94] The results (not shown here) of ADF unit-root tests on the countries' relative price and income series corroborate this statement with very few exceptions. In most cases both series are non-stationary, and in all cases at least one is.

[95] Tests for the full period 1950-2000 lead to the same conclusion (results not shown here.)

regressions in Table 4.7, that the correction for cross-country heteroscedasticity and correlation helps the fit of the model.

Continuing with the time-series robustness checks, Table 4.8 shows the results of estimating short-run ECM relationships between the relative price and relative income series of the countries. The focus is on the coefficients of the Error Correction term U_{t-1}. They must be negative and statistically significant if the relative price and relative income series are cointegrated. Table 4.8 shows that this is in fact the case for the pooled results, and for practically all the country-specific results. For the sub-period 1950-1971, the coefficients for U_{t-1} for Ecuador and Guatemala are positive but non-significant, and for the sub-period 1972-2000, Panama's U_{t-1} coefficient is non-significant but negative as expected. It is important to notice that the Durbin-Watson values are close to 2 in all cases, indicating that serial correlation is not a problem, and that the reported standard errors for the coefficients are reliable for hypothesis testing. The results are, thus, consistent with the results of the ADF unit-root tests shown in Table 4.7, although with some minor differences due to the different estimation method used.

With respect to the short-run effect of relative income on relative price, the pooled estimates for the coefficient of $\Delta y'_{i,t}$ suggest a non-existent relationship for the sub-period 1950-1971 and a positive and significant relationship for the sub-period 1972-2000. For the first sub-period, the estimated coefficient for $\Delta y'_{i,t}$ is small (-0.044) and non-significant. On the other hand, for the second sub-period, the average Latin American country's relative price level growth is expected to increase by a statistically significant 0.571% due to a 1% increase in the relative income level growth in a given year. For this sub-period too, the estimated intercept (0.005) is very small and non-significant, as

Table 4.8. Error-Correction Panel Regressions of Relative Price on Relative Real Per-Capita GDP

Assuming Common Coefficients

	Sub-Period 1950-1971			Sub-Period 1972-2000		
Country	Intercept	$\Delta y'_{i,t}$	U_{t-1}	Intercept	$\Delta y'_{i,t}$	U_{t-1}
Pooled	-0.016 ***	-0.044	-0.175 ***	0.005	0.571 ***	-0.339 ***
	(0.003)	(0.055)	(0.024)	(0.005)	(0.084)	(0.037)
R^2:	0.201 [w]	0.116 [uw]		0.257 [w]	0.195 [uw]	
DW:	1.862 [w]	1.887 [uw]		1.903 [w]	1.813 [uw]	

Assuming Country-Specific Coefficients

	Sub-Period 1950-1971			Sub-Period 1972-2000		
Country	Intercept	$\Delta y'_{i,t}$	U_{t-1}	Intercept	$\Delta y'_{i,t}$	U_{t-1}
Argentina	-0.034	0.393	-0.113 *	0.015	1.248 ***	-0.935 ***
	(0.037)	(0.332)	(0.064)	(0.049)	(0.400)	(0.103)
Brazil	-0.020	-1.555 ***	-0.340 ***	-0.006	0.952 *	-0.371 ***
	(0.030)	(0.497)	(0.097)	(0.026)	(0.518)	(0.114)
Chile	-0.020	-0.757 ***	-0.239 ***	-0.015	-0.745 *	-0.339 ***
	(0.027)	(0.287)	(0.057)	(0.030)	(0.440)	(0.096)
Colombia	-0.037	1.250 **	-0.135 *	-0.003	0.581 *	-0.221 ***
	(0.026)	(0.510)	(0.072)	(0.013)	(0.325)	(0.055)
Costa Rica	-0.016 **	-0.397 ***	-0.081 *	0.043	2.538 ***	-0.277 **
	(0.008)	(0.106)	(0.044)	(0.030)	(0.832)	(0.113)
Ecuador	-0.014	-0.377	0.141	-0.005	0.630 ***	-0.474 ***
	(0.011)	(0.237)	(0.181)	(0.017)	(0.205)	(0.102)
Guatemala	-0.017 ***	-0.215 ***	0.053	0.005	0.226	-0.434 ***
	(0.005)	(0.070)	(0.036)	(0.017)	(0.361)	(0.087)
Mexico	0.018 **	-0.442 ***	-0.337 ***	0.017	2.077 ***	-0.549 ***
	(0.009)	(0.116)	(0.047)	(0.022)	(0.448)	(0.094)
Panama	-0.016 ***	-0.347 ***	-0.296 ***	-0.007	0.045	-0.107
	(0.006)	(0.097)	(0.085)	(0.007)	(0.109)	(0.079)
Paraguay	-0.029	0.350	-0.305 ***	-0.003	1.164 ***	-0.190 **
	(0.023)	(0.300)	(0.069)	(0.025)	(0.335)	(0.075)
Peru	-0.010	0.331	-0.340 ***	0.024	0.846 ***	-0.354 ***
	(0.017)	(0.233)	(0.104)	(0.027)	(0.251)	(0.092)
Uruguay	0.013	1.040 ***	-0.504 ***	0.020	1.319 ***	-0.488 ***
	(0.026)	(0.252)	(0.089)	(0.022)	(0.233)	(0.074)
Venezuela	-0.012	0.140	-0.513 ***	0.007	0.647	-0.223 **
	(0.027)	(0.397)	(0.145)	(0.032)	(0.474)	(0.100)
R^2:	0.579 [w]	0.200 [uw]		0.506 [w]	0.279 [uw]	
DW:	1.939 [w]	1.712 [uw]		1.944 [w]	1.665 [uw]	

Note: The dependent variable is always $\Delta q'_{i,t}$. Variable U_{t-1} is the lagged Error Correction term, which is obtained individually for each country as the residual series of the OLS regression of the relative price on the relative real per-capita GDP in levels. All regressions are estimated with the 13 countries as a panel using the Seemingly Unrelated Regression (SUR) method. The R^2 and the Durbin Watson (DW) statistics are reported in both weighted ([w]) and unweighted ([uw]) form. The results are practically unchanged when Panama is excluded from the panels. The panel for the sub-period 1950-1971 is unbalanced because Chile, Ecuador and Paraguay do not have data for 1950. Standard errors are reported in parentheses, and one, two and three asterisks indicate statistical significance of the coefficient at 10%, 5% and 1%, respectively.

expected. In addition, the country-specific intercepts are all found to be non-significant, and the coefficients for the relative income growth variable are positive for all countries with Chile as the only exception.

It is worthwhile mentioning that for the sub-period 1950-1971, the estimated intercept for the pooled regression, although small in size, is statistically significantly negative (-0.016). This result implies that for the average Latin American country, the relative price level decreases during this sub-period at a rate of about 1.6% per year for reasons that have nothing to do with relative income growth. This result may be mainly due to the negative trends in the relative price series of Guatemala and Panama, the only two countries that kept a fixed exchange rate with the U.S. dollar during this sub-period. In any case, this exogenous decrease in relative prices is not inconsistent with an almost nonexistent Balassa-Samuelson effect in this sub-period, and with an adjustment needed for relative prices to become more closely related with relative incomes in the following decades.

Consistent with the results of the cross-section analysis, the time-series analysis results also suggest that Panama's observation is not influential. The pooled results shown in Table 4.7 and all the results shown in Table 4.8 remain practically unchanged when Panama is excluded from the panel estimations. In addition, the estimated δ values for Panama shown in Table 4.7 are between the country-specific minimum and maximum values for both sub-periods. In fact, for the sub-period 1970-2000, the δ estimate for Panama (0.744) is comparable to the pooled value (0.498). However, according to the country-specific results in Table 4.8 for the sub-period 1972-2000, Panama presents certain particularities. Panama's coefficient for the Error Correction term U_{t-1} (-0.107) is

the only one to be found non-significant, and is the smallest in absolute value. This could be an indication that Panama's mechanism for maintaining a long-run relationship between relative price and relative income is not as strong as is for the other countries; or it may be the result of including Panama, with its extremely low ratio of price volatility to income volatility, in a panel where the series of the other countries are fairly noisy.

It is important to mention that in the time-series analysis of this section, each country was allowed to have its own cointegrating relationship between relative price and relative income. However, this flexibility in the analysis does not drive the results. If the Error Correction terms for all countries are obtained using the same coefficients for equation (4.20) rather than country-specific coefficients, the results in Table 4.8 change only slightly and the conclusions of the analysis remain the same.[96]

5. Balassa-Samuelson, Non-Tradables and Tradables

So far this study has found that the real exchange rates for the average Latin American country and for Panama relative to the U.S. violate PPP, and that the reason seems to be price divergence justified by a Balassa-Samuelson effect at work. The typical explanation for this effect assumes that PPP holds for tradables so that any overall relative price level divergence is, in the long run, driven by the relative price level of non-tradables. However, no evidence has been given that this assumption and the implication are correct in practice. This section addresses this issue.

After substituting country *i*'s and the U.S. CPIs with the functions in equations (4.10) and (4.11), equation (4.1) can be written in the following general form:

[96] For example, based on the cross-sectional results, the panel regressions for the period 1972-2000 shown in Table 4.8 can be estimated assuming $\mu = 0.119$ and $\delta = 0.512$ (or $\mu = 0$ and $\delta = 0.5$), and the conclusions will not change.

$$q_i = [\theta_i (p_{i,N} - e_i) - \theta^* p_N^*] + [(1-\theta_i)(p_{i,T} - e_i) - (1-\theta^*) p_T^*] \quad (4.21)$$

which after assuming that $\theta_i = \theta^*$ reduces to[97]:

$$q_i = \theta_i (p_{i,N} - e_i - p_N^*) + (1-\theta_i)(p_{i,T} - e_i - p_T^*) \quad (4.22)$$

which can be expressed in growth terms by simply first-differencing:

$$\Delta q_i = \theta_i \Delta (p_{i,N} - e_i - p_N^*) + (1-\theta_i)\Delta (p_{i,T} - e_i - p_T^*) \quad (4.23)$$

According to equation (4.23) the growth of the real exchange rate (or we can say the relative price level) between country *i* and the U.S. depends on the growth of the common currency price levels of the non-tradable component, $\Delta(p_{i,N} - e_i - p_N^*)$, and the tradable component, $\Delta(p_{i,T} - e_i - p_T^*)$. However, if PPP holds for tradables, the latter term becomes zero, and the non-tradables become the driving force.

In this section, the two component terms in equations (4.22) and (4.23) are estimated using data from the Economist Intelligence Unit (EIU). The EIU provides annual domestic prices for 109 commodities, of which 24 are classified as non-tradable and 85 as tradable, for the capital cities of the 13 Latin American countries analyzed in this study and for Pittsburgh in the U.S. for the period 1990-2000. The list of commodities is shown in Appendix B.[98] The EIU also provides the countries' nominal exchange rates prevailing at the price collection time, so that all prices can be converted to U.S. dollars. Using these data, the annual series for the dollar price levels of both non-tradables, $p_{i,N} - e_i$, and

[97] The assumption of equal CPI weights across countries for the tradable and non-tradable components is a simplifying assumption. Actually, the U.S. gives relatively greater weight to the non-tradable component than the typical Latin American country. However, the classification of a commodity as tradable or non-tradable is not as straightforward as it may seem either. In practice, no commodity is 100% of either type.

[98] Utilities, rent, lodging and services in general are classified as non-tradable, and agricultural and manufactured commodities as tradable. The EIU provides prices for more than 190 commodities but the list was restricted to only those commodities with non-missing data for all countries and all years. In some cases, there are prices for the same commodity but for a different type of store. For the purposes of this section, these prices are considered as if they were for different commodities.

tradables, $p_{i,T}$ - e_i, are calculated, for each country i, as the simple average of the log of the dollar prices of the corresponding sets of commodities j (the time subscript is ignored for simplicity):

$$p_{i,N} - e_i = \frac{1}{24}\sum_{j=1}^{24}(p_{i,N,j} - e_i) \tag{4.24}$$

$$p_{i,T} - e_i = \frac{1}{85}\sum_{j=1}^{85}(p_{i,T,j} - e_i) \tag{4.25}$$

For each country, Part A of Table 4.9 shows the mean and standard deviation for these price levels and their growth rates. Part B of Table 4.9 shows the same statistics for the *relative* price levels of the countries with respect to the U.S., calculated using the series obtained with equations (4.24) and (4.25). The relative prices for non-tradables and tradables are $p_{i,N}$ - e_i - p_N* and $p_{i,T}$ - e_i - p_T*, respectively, as shown in equation (4.22).

Because the purpose of this section of the study is to draw implications about long-run concepts such as PPP and the Balassa-Samuelson hypothesis, the focus will be on Panama. No long-run predictions can be made using a short period such as 1990-2000, unless the price series are very stable. According to the results presented in the previous sections of this chapter, only Panama meets this criterion. Table 4.9 confirms this: the standard deviation values for Panama's series are always the lowest among the Latin American countries. Still, the short length of the series would make it difficult to statistically detect small differences even for Panama. For this reason, the conclusions from this section can only be tentative.

The statistics in Table 4.9 show certain particularities of the data used. First, the mean price level for non-tradables is higher than that for tradables, indicating that the former group of commodities is on average more expensive than the latter group

(Compare 3.79 to 1.43 and 3.87 to 1.71 for the average Latin American country and the U.S., respectively.)

Table 4.9. Price Level Statistics by Type of Commodity (EIU Data, Period 1990-2000)

Part A: Price Level

	Non-Tradable Commodities (N)				Tradable Commodities (T)			
	Level		Growth (%)		Level		Growth (%)	
Country	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Argentina	4.22	0.21 ***	6.50	12.15	1.70	0.16 ***	5.18	7.29
Brazil	4.15	0.32 ***	-0.57	27.05	1.49	0.24 ***	-1.41	22.91
Chile	3.89	0.27 ***	5.01	10.13	1.41	0.16 ***	3.15	7.75
Colombia	3.60	0.24 ***	2.94	15.04	1.35	0.17 ***	3.56	9.43
Costa Rica	3.49	0.14 ***	3.19	7.30	1.34	0.09 ***	1.05	5.80
Ecuador	3.32	0.33 ***	6.50	20.80	1.15	0.20 ***	5.15	17.32
Guatemala	3.78	0.32 ***	10.56	12.46 **	1.49	0.17 ***	5.04	11.76
Mexico	4.05	0.19 ***	6.91	16.07	1.54	0.22 ***	8.10	15.88
Panama	3.90	0.10 ***	2.76	4.40	1.48	0.10 ***	3.17	3.62 **
Paraguay	3.70	0.27 ***	5.58	15.50	1.22	0.12 ***	1.52	8.16
Peru	3.80	0.23 ***	5.39	10.15	1.45	0.09 ***	0.57	7.20
Uruguay	3.82	0.20 ***	5.81	11.47	1.54	0.10 ***	2.12	6.23
Venezuela	3.56	0.39 ***	10.94	24.33 *	1.46	0.21 ***	4.83	17.10
Average:	3.79	0.25	5.50	14.37	1.43	0.16	3.23	10.80
USA	3.87	0.14 ***	4.12	2.90 ***	1.71	0.11 ***	2.84	2.41 ***

Part B: Relative Price Level

	Level		Growth (%)		Level		Growth (%)	
Country	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Argentina	0.35	0.13 ***	2.38	10.55	-0.01	0.10	2.34	8.44
Brazil	0.28	0.27 **	-4.68	26.28	-0.22	0.21 **	-4.25	21.26
Chile	0.02	0.16	0.89	9.09	-0.30	0.09 ***	0.31	7.38
Colombia	-0.27	0.20 ***	-1.17	12.90	-0.36	0.11 ***	0.72	8.84
Costa Rica	-0.38	0.09 ***	-0.93	5.10	-0.37	0.11 ***	-1.79	6.27
Ecuador	-0.55	0.26 ***	2.38	18.97	-0.56	0.18 ***	2.31	17.24
Guatemala	-0.09	0.19	6.45	11.09 *	-0.22	0.12 ***	2.20	11.99
Mexico	0.18	0.14 ***	2.79	14.29	-0.17	0.17 **	5.26	16.08
Panama	0.03	0.08	-1.35	4.32	-0.23	0.04 ***	0.33	4.04
Paraguay	-0.17	0.19 *	1.47	13.13	-0.49	0.09 ***	-1.33	7.00
Peru	-0.10	0.14	1.29	9.82	-0.27	0.06 ***	-2.50	5.98
Uruguay	-0.05	0.10	1.69	11.30	-0.17	0.07 ***	-0.72	6.50
Venezuela	-0.31	0.27 **	6.83	23.56	-0.25	0.12 ***	1.99	16.04
Average:	-0.08	0.17	1.39	13.11	-0.28	0.11	0.37	10.54

Note: (*)(**)(***) One, two and three asterisks indicate statistical significance at 10%, 5% and 1%, respectively, for a test for zero mean that uses Newey-West HAC standard errors. The "Average" values are simple column averages. These values are not tested. Price levels are averages of the log prices in dollars of a set of commodities from the Economist Intelligence Unit (EIU). Growth series are the first differences of the price level series. The statistics are obtained from the price level and growth series for the period 1990-2000 for all countries except Peru for which the 1990 data are missing. All series are annual.

Second, the mean relative price level for tradables (-0.28) is not closer to zero than for non-tradables (-0.08) for the average Latin American country. This seems to be the result of certain countries' (Argentina, Brazil, Chile, Mexico and Panama) having a mean relative price level for non-tradables that is positive, indicating that this set of commodities is more expensive in those countries than in the U.S. The mean relative price level for tradables is negative for all countries, indicating that this set of commodities is consistently cheaper in the Latin American countries than in the U.S. However, the cross-country spread of mean relative prices is greater for non-tradables than for tradables, just as expected.[99] Third, in terms of price growth, the U.S. has a lower standard deviation of the growth rate than the average Latin American country for both groups of commodities (compare 2.90% to 14.37% and 2.41% to 10.80% between the U.S. and the average Latin American country for non-tradables and tradables, respectively.) This reflects the greater price stability of the U.S. economy. Finally, the mean growth rate of the price of non-tradables is greater than that for tradables for both the U.S. (4.12% versus 2.84%) and the average Latin American country (5.50% versus 3.23%.)

Panama's mean growth values presented in Table 4.9 make it apparent that a "typical" Balassa-Samuelson effect is indeed at work. First, the fairly small mean growth rate for the relative price of tradables, 0.33%, and its relatively small standard deviation, 4.04%, are both consistent with relative PPP holding for the tradable commodities. Second, the negative growth rate for the relative price of non-tradables, -1.35%, is consistent with the long-run depreciating trend of Panama's real exchange rate observed

[99] The cross-country standard deviation of mean relative prices is 0.261 for non-tradables and 0.143 for tradables (not shown in Table 4.9.)

in the previous sections (Refer to Table 4.2, which indicates that Panama's real exchange rate depreciated at an average 1.68% per year during the period 1950-2000.) As predicted by the Balassa-Samuelson hypothesis, for Panama the driving force behind real exchange rate movements seems to be the relative price of non-tradables. With respect to the average Latin American country, no clear effect can be appreciated due to the high volatility of the growth values.

With respect to relative productivity between Panama and the U.S., some interesting assessments can be made. According to the Balassa-Samuelson hypothesis, the depreciating trend of the relative price of non-tradables and the resulting depreciating trend of the real exchange rate is an indication that productivity growth in the production of tradables is faster in the U.S. than in Panama. This requires the assumption that productivity growth in the production of non-tradables be roughly the same in both countries and that PPP hold for tradables. To understand this more clearly, we can express the growth of the relative price of non-tradables as[100]:

$$(\Delta p_{i,N} - \Delta p_N^*) = (\Delta p_{i,T} - \Delta p_T^*) + (\Delta a_{i,T} - \Delta a_T^*) - (\Delta a_{i,N} - \Delta a_N^*) \qquad (4.26)$$

If PPP holds for tradables and productivity in the production of non-tradables is the same in both countries, the first and third terms on the right-hand side of equation (4.26) both become zero, so that the growth of the relative price of non-tradables depends only on the growth differential in the productivity in the production of tradables between the two countries. According to the results presented in this section, for Panama, the term on the left-hand side of equation (4.26) is negative, and PPP holding for tradables seems to be a sensible approximation. However, according to Goldfajn and Olivares (2001) the

[100] This is obtained by first-differencing equations (4.15) and (4.16), and then subtracting (4.16) from (4.15) and re-arranging.

third term on the right-hand side is probably not zero. The authors suggest that Panama may have become more productive than the U.S. in the production of non-tradables. This seems plausible since the results presented in Table 4.9 show that the price level of non-tradables grows slower than the price level of tradables for Panama (2.76% versus 3.17% per year.) This is not a common occurrence. For both, the U.S. and the average Latin American country the opposite is true. If the authors' claim is correct, then the third term on the right-hand side of equation (4.26) would be positive, reinforcing the negative trend on the relative price of non-tradables. This conclusion is in line with an argument made by Frankel (2001).

6. Conclusion

This study contributes to the scarce literature on dollarization by presenting an analysis on long-run price level convergence that compares the experience of dollarized Panama with that of other 12 non-dollarized Latin American countries during the period 1950-2000. Being Panama a small country under a dollarized system since 1904, greater integration to the anchor country, the U.S., is expected in several aspects including the price level. However, the analyses presented in this chapter could not find evidence of price level integration to U.S. levels.

For Panama, dollarization seems to have contributed to both price stability and trade integration with the U.S. but not to faster economic growth. For the period of analysis, 1950-2000, Panama has an outstandingly low and stable inflation, which is generally lower than that of the U.S. As a consequence, Panama is the country with the smoothest real exchange rate series of all the Latin American countries used in this study. In

addition, Panama is one of the most open economies and one of the most influenced by the U.S. through trade. In this sense, Panama is comparable to Mexico, a country that shares a border and has trade agreements with the U.S. In terms of real per-capita GDP growth, however, Panama has performed just like the average non-dollarized Latin American country, growing acceptably during the sub-period 1950-1971, but then stagnating during the sub-period 1972-2000.

With respect to whether dollarization has contributed to a movement of the price level of Panama closer to the U.S. price level, this study finds evidence of the opposite. As for the average non-dollarized Latin American country, the bilateral real exchange rate versus the U.S. for Panama presents a long-run tendency to depreciate. In fact, for both Panama and the average Latin American country, the average annual rate of depreciation of the real exchange rate for the period 1950-2000 is roughly the same. In addition, a univariate unit-root test for Panama and several panel tests for the Latin American countries as a group reject that PPP holds. These results do not seem to depend on the economic characteristics of the countries as they are diverse in terms of openness, intensity of trade with the U.S., inflation performance, and exchange rate regime. For a typical developing country, with a price level lower than that of the U.S., these results would indicate further price level divergence. An analysis that explicitly uses data on price levels confirms the existence of this divergence for both Panama and the average Latin American country.

Although the price levels of the Latin American countries are diverging from the U.S. price level, they seem to be converging to a positive relationship with per-capita income. For these countries, a Balassa-Samuelson effect seems to be at work, particularly

for the more recent sub-period 1972-2000 during which the countries experienced an increase in overall integration to the world markets. Considering this relationship, the price level of dollarized Panama does not seem to be getting closer to the U.S. price level than expected for a country with Panama's income level. That is, income explains fairly well the level of prices, and the exchange rate system, whether is dollarization or not, seems not to be relevant. A question for future research is whether the income level of Panama may have been affected by dollarization in earlier periods.

This chapter also presented an analysis of the fundamental assumption and implication of the Balassa-Samuelson hypothesis for Panama. For this, price levels for the two types of commodities, tradables and non-tradables, are obtained from commodity price data. The results of the analysis suggest that PPP's holding for tradables is a reasonable assumption for Panama, and that the continuous depreciation of this country's real exchange rate is mainly driven by a depreciating price of non-tradables relative to the U.S. According to the Balassa-Samuelson hypothesis, the reason for this would be that productivity growth has consistently lagged in Panama relative to the U.S. This implication could well be extended to the average Latin American country. Although some results suggest that Panama may have also become more efficient in the production of non-tradables, more research is needed to reach a more definite conclusion.

APPENDIX A

FIVE MAIN TRADE PARTNERS OF THE 13 LATIN AMERICAN COUNTRIES AND THE U.S.

Argentina

M1960		X1960		M1980		X1980		M2000		X2000	
USA	26.2	UK	20.5	USA	22.6	Russia	20.1	Brasil	25.9	Brazil	26.5
Germa.	12.1	Netherl.	12.1	Brazil	10.2	Brazil	9.5	USA	19.1	USA	11.9
UK	9.1	Italy	11.8	Germa.	9.3	USA	8.9	Germa.	5.1	Chile	10.1
Venezu.	7.2	USA	8.5	Japan	9.3	Netherl.	8.9	China	4.4	Spain	3.5
Italy	6.9	Germa.	8.0	Italy	5.5	Italy	6.5	Italy	4.0	Uruguay	3.1

Brazil

M1960		X1960		M1980		X1980		M2000		X2000	
USA	30.3	USA	44.4	USA	18.5	USA	17.4	USA	23.2	USA	24.5
Germa.	9.3	Germa.	7.1	Iraq	15.8	Germa.	6.6	Argenti.	12.2	Argenti.	11.3
Venezu.	7.8	UK	5.1	S. Arabia	8.7	Japan	6.1	Germa.	7.8	Netherl.	5.1
Argenti.	6.5	Argenti.	4.4	Germa.	7.0	Netherl.	5.7	Japan	5.3	Germa.	4.6
France	4.7	Netherl.	4.1	Japan	4.8	Argenti.	5.4	Italy	3.9	Japan	4.5

Chile

M1960		X1960		M1980		X1980		M2000		X2000	
USA	47.8	USA	37.2	USA	25.4	Japan	11.1	USA	19.7	USA	16.5
Germa.	11.6	UK	17.7	Brazil	8.4	Brazil	10.0	Argenti.	17.2	Japan	14.0
Argenti.	7.9	Germa.	15.5	Japan	8.1	USA	10.0	Brazil	8.0	UK	5.8
UK	7.1	Netherl.	8.0	Germa.	5.6	Germa.	9.1	China	5.7	Brazil	5.3
Peru	4.4	Argenti.	3.6	Venezu.	5.2	Netherl.	9.1	Japan	4.2	China	5.0

Colombia

M1960		X1960		M1980		X1980		M2000		X2000	
USA	57.1	USA	64.1	USA	39.5	USA	27.1	Germa.	42.9	USA	50.6
Germa.	10.3	Germa.	11.8	Japan	9.3	Germa.	18.8	USA	34.0	Venezu.	9.9
UK	5.9	Netherl.	5.3	Germa.	7.2	Venezu.	7.1	Venezu.	8.2	Ecuador	3.5
France	3.0	UK	4.4	Venezu.	4.2	Netherl.	6.9	Mexico	4.7	Germa.	3.3
Japan	2.6	Sweden	2.3	Spain	3.1	Spain	3.8	Japan	4.6	Peru	2.8

Costa Rica

M1960		X1960		M1980		X1980		M2000		X2000	
USA	46.8	USA	52.0	USA	34.5	USA	34.9	USA	51.3	USA	52.0
Germa.	11.5	Germa.	24.4	Japan	10.8	Nicaragua	12.4	Mexico	6.5	Netherl.	7.2
Japan	7.2	Belgium	3.9	Venezu.	6.8	Germa.	11.4	Venezu.	5.6	UK	5.5
UK	5.8	Netherl.	3.5	Guatem.	6.3	Guatem.	6.4	Japan	3.6	Guatem.	3.5
Netherl.	3.7	Italy	2.1	Mexico	6.1	El Salv.	5.1	Spain	2.4	Nicarag.	3.3

Ecuador

M1960		X1960		M1980		X1980		M2000		X2000	
USA	48.3	USA	62.2	USA	38.9	USA	32.5	USA	25.6	USA	37.9
Germa.	12.8	Germa.	10.7	Japan	13.9	Neth. Ant.	24.0	Colombia	14.2	Korea	6.6
Belgium	8.3	Belgium	4.5	Germa.	7.4	Japan	12.3	Venezu.	7.9	Panama	6.1
UK	5.7	Italy	3.1	Italy	5.2	Chile	8.9	Chile	5.8	Peru	6.0
Sweden	4.3	Venezu.	2.8	Peru	3.6	Colombia	3.8	Brazil	4.0	Colombia	5.4

Guatemala

M1960		X1960		M1980		X1980		M2000		X2000	
USA	49.0	USA	55.7	USA	33.7	USA	28.7	USA	39.7	USA	36.1
Germa.	12.0	Germa.	20.4	Neth. Ant.	9.8	El Salv.	12.3	Mexico	11.7	El Salv.	12.6
Neth. Ant.	6.1	Japan	4.9	Venezu.	9.4	Germa.	8.0	El Salv.	6.4	Honduras	8.6
Japan	4.4	Netherl.	4.4	Japan	8.3	Nicaragua	5.6	Venezu.	5.4	Costa R.	4.7
El Salv.	4.3	El Salv.	3.9	Germa.	5.7	Costa R.	5.6	Costa R.	4.1	Mexico	4.5

Mexico

M1960		X1960		M1980		X1980		M2000		X2000	
USA	72.2	USA	59.7	USA	61.6	USA	65.8	USA	73.1	USA	88.6
Germa.	6.2	Japan	5.8	Japan	5.1	Spain	8.1	Japan	4.0	Canada	2.0
UK	4.9	Germa.	2.4	Germa.	5.0	Japan	4.4	Germa.	3.2	Spain	0.9
Canada	2.8	Netherl.	2.2	France	2.7	Israel	4.2	Canada	2.2	Germa.	0.9
Italy	2.1	UK	1.6	Brazil	2.4	France	3.7	Korea	2.1	Japan	0.6

Panama

M1960		X1960		M1980		X1980		M2000		X2000	
USA	51.7	USA	96.0	USA	33.8	USA	49.9	USA	33.1	USA	45.9
Canal Z.	9.4	Germa.	1.3	S. Arabia	18.6	Costa R.	6.4	Free Zo.	11.9	Sweden	8.1
Colon Z.	8.0	Venezu.	0.7	Venezu.	7.6	Netherl.	5.8	Ecuador	7.2	Costa R.	5.2
Germa.	5.1	Colon Z.	0.5	Japan	6.0	Germa.	5.2	Venezu.	6.6	Belgium	5.1
UK	4.1	Canada	0.5	Costa R.	2.6	Nicaragua	3.0	Japan	5.5	Italy	3.2

Paraguay

M1960		X1960		M1980		X1980		M2000		X2000	
USA	23.5	Argenti.	28.4	Brazil	27.2	Argenti.	23.9	Brazil	24.5	Brazil	38.6
Argenti.	23.0	USA	26.8	Argenti.	20.6	Brazil	13.0	Argenti.	23.3	Uruguay	14.1
Germa.	11.4	UK	10.6	USA	9.9	Germa.	12.4	China	11.4	Argenti.	10.7
Spain	7.6	Netherl.	8.2	Japan	8.1	Switzer.	10.2	USA	7.3	Netherl.	7.1
Neth. Ant.	7.5	Uruguay	4.3	Algeria	7.2	Netherl.	6.4	Japan	4.7	Chile	5.7

Peru

M1960		X1960		M1980		X1980		M2000		X2000	
USA	43.9	USA	36.2	USA	36.7	USA	32.4	USA	23.4	USA	28.0
Germa.	11.4	Germa.	10.1	Japan	10.4	Japan	8.8	Venezu.	8.4	UK	8.4
UK	6.9	Belgium	9.4	Germa.	8.4	Germa.	5.5	Japan	6.6	Switzer.	8.0
Argenti.	4.7	Netherl.	7.8	Argenti.	4.1	Italy	4.4	Colombia	5.4	China	6.4
Netherl.	3.8	UK	7.8	UK	3.8	UK	3.5	Chile	5.3	Japan	4.7

Uruguay

M1960		X1960		M1980		X1980		M2000		X2000	
USA	26.9	UK	23.7	Brazil	17.3	Brazil	18.0	Argenti.	24.1	Brazil	23.1
Venezu.	15.4	USA	15.3	Iraq	12.8	Argenti.	13.4	Brazil	19.2	Argenti.	17.9
UK	7.8	Netherl.	13.2	Argenti.	10.5	Germa.	12.9	USA	9.8	USA	8.3
Germa.	7.3	Germa.	9.3	USA	9.8	USA	7.8	Venezu.	4.3	China	4.0
Brazil	6.3	France	6.4	Nigeria	8.1	Russia	4.6	France	4.2	Germa.	3.9

USA

M1960		X1960		M1980		X1980		M2000		X2000	
Canada	21.1	Canada	17.9	Canada	16.3	Canada	15.6	Canada	18.5	Canada	22.2
Japan	7.5	UK	6.8	Japan	13.1	Japan	9.5	Japan	12.0	Mexico	14.1
UK	6.6	Japan	6.5	S. Arabia	5.3	Mexico	6.9	Mexico	10.9	Japan	8.5
Venezu.	6.3	Germa.	5.2	Mexico	5.1	UK	5.3	China	8.6	UK	5.3
Germa.	6.0	Mexico	3.9	Germa.	4.9	Germa.	4.9	Germa.	4.8	Germa.	3.8

Venezuela

M1960		X1960		M1980		X1980		M2000		X2000	
USA	51.7	USA	43.9	USA	48.1	USA	27.3	USA	37.8	USA	59.6
Germa.	8.9	Neth. Ant.	23.1	Japan	8.0	Netherl.	22.0	Colombia	7.4	Neth. Ant.	5.6
Italy	6.3	UK	7.5	Germa.	6.3	Canada	9.6	Brazil	5.0	Brazil	3.6
UK	6.0	Brazil	3.3	Canada	4.6	Italy	5.6	Italy	4.4	Domin. R.	2.8
Canada	3.7	Canada	3.1	Italy	4.0	Japan	3.6	Mexico	4.3	Colombia	2.8

Note: X=Exports, M=Imports. Values shown are percentages of total exports or total imports.

APPENDIX B

LIST OF THE 109 COMMODITIES FROM THE ECONOMIST INTELLIGENCE UNIT

Tradable Commodities

White bread, 1 kg (supermarket)
White bread, 1 kg (mid-priced store)
Butter, 500 g (supermarket)
Margarine, 500g (supermarket)
Margarine, 500g (mid-priced store)
White rice, 1 kg (supermarket)
White rice, 1 kg (mid-priced store)
Sugar, white (1 kg) (supermarket)
Sugar, white (1 kg) (mid-priced store)
Cheese, imported (500 g) (mid-priced store)
Milk, pasteurised (1 l) (mid-priced store)
Peanut or corn oil (1 l) (supermarket)
Peanut or corn oil (1 l) (mid-priced store)
Potatoes (2 kg) (supermarket)
Potatoes (2 kg) (mid-priced store)
Onions (1 kg) (mid-priced store)
Tomatoes (1 kg) (mid-priced store)
Carrots (1 kg) (mid-priced store)
Apples (1 kg) (mid-priced store)
Lemons (1 kg) (mid-priced store)
Bananas (1 kg) (mid-priced store)
Lettuce (one) (mid-priced store)
Eggs (12) (supermarket)
Eggs (12) (mid-priced store)
Peas, canned (250 g) (mid-priced store)
Peaches, canned (500 g) (mid-priced store)
Beef: filet mignon (1 kg) (mid-priced store)
Beef: steak, entrecote (1 kg) (mid-priced store)
Beef: stewing, shoulder (1 kg) (mid-priced store)
Beef: roast (1 kg) (mid-priced store)
Beef: ground or minced (1 kg) (mid-priced store)
Pork: chops (1 kg) (mid-priced store)
Pork: loin (1 kg) (mid-priced store)
Bacon (1 kg) (supermarket)
Chicken: fresh (1 kg) (mid-priced store)
Instant coffee (125 g) (mid-priced store)
Tea bags (25 bags) (supermarket)
Coca-Cola (1 l) (supermarket)
Coca-Cola (1 l) (mid-priced store)
Mineral water (1 l) (mid-priced store)
Wine, common table (1 l) (supermarket)
Wine, common table (1 l) (mid-priced store)
Soap (100 g) (supermarket)
Soap (100 g) (mid-priced store)
Laundry detergent (3 l) (mid-priced store)
Toilet tissue (two rolls) (supermarket)
Toilet tissue (two rolls) (mid-priced store)
Light bulbs (two, 60 watts) (mid-priced store)
Frying pan (Teflon or good equivalent) (mid-pr store)
Razor blades (five pieces) (mid-priced store)
Toothpaste with fluoride (120 g) (supermarket)
Toothpaste with fluoride (120 g) (mid-priced store)
Facial tissues (box of 100) (mid-priced store)
Hand lotion (125 ml) (supermarket)
Lipstick (deluxe type) (supermarket)
Lipstick (deluxe type) (mid-priced store)
Cigarettes, local brand (pack of 20) (supermarket)
Cigarettes, local brand (pack of 20) (mid-priced store)
Business suit, two piece, medium weight (chain store)
Business shirt, white (chain store)
Men's shoes, business wear (chain store)
Men's shoes, business wear (mid-priced/branded store)
Socks, wool mixture (chain store)
Socks, wool mixture (mid-priced/branded store)
Dress, ready to wear, daytime (chain store)
Dress, ready to wear, daytime (mid-priced/branded store)
Women's shoes, town (chain store)
Women's shoes, town (mid-priced/branded store)
Tights, panty hose (chain store)
Tights, panty hose (mid-priced/branded store)
Child's jeans (chain store)
Child's jeans (mid-priced/branded store)
Child's shoes, dresswear (chain store)
Child's shoes, dresswear (mid-priced/branded store)
Child's shoes, sportswear (chain store)
Child' s shoes, sportswear (mid-priced/branded store)
Girl's dress (chain store)
Girl's dress (mid-priced/branded store)
Compact disc album (average)
Television, colour (66 cm) (average)
Kodak colour film (36 exposures) (average)
International foreign daily newspaper (average)
International weekly news magazine (Time) (average)
Paperback novel (at bookstore) (average)
Regular unleaded petrol (1 l) (average)

Non-Tradable Commodities

Dry cleaning, man's suit (mid-priced outlet)
Dry cleaning, woman's dress (mid-priced outlet)
Dry cleaning, trousers (mid-priced outlet)
Man's haircut (tips included) (average)
Woman's cut & blow dry (tips included) (average)
Electricity, monthly bill (average)
Water, monthly bill (average)
Cost of developing 36 colour pictures (average)
Daily local newspaper (average)
Three course dinner for four people (average)
Four best seats at cinema (average)
Cost of a tune up (but no major repairs) (low)
Cost of a tune up (but no major repairs) (high)
Furnished residential apartment: 1 bedroom (moderate)
Furnished residential apartment: 2 bedroom (moderate)
Furnished residential apartment: 2 bedroom (high)
Unfurnished residential apartment: 2 bedrooms (moderate)
Unfurnished residential apartment: 2 bedrooms (high)
Hilton-type hotel, single room, one night incl. breakfast (av.)
Moderate hotel, single room, one night incl. breakfast (av.)
One drink at bar of first class hotel (average)
Two-course meal for two people (average)
Simple meal for one person (average)
One good seat at cinema (average)

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