

Interest Rate Adjustment Mechanisms as a Response to External Shocks: Evidence from Argentina's Convertibility Plan (1991-2002)

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Abstract

From 1991 to 2002, Argentina engaged in an economic stabilization strategy, the “Convertibility Plan,” that fixed the national currency to the U.S. dollar. This article analyzes how the counter-cyclical role of domestic interest rates contributed to the Plan’s collapse, as it changed investors’ confidence on the commitment of policymakers to continue with unpopular recessionary and deflationary adjustment policies. To reach this conclusion, this article – using univariate and multivariate techniques (cointegration) with monthly data from 1991 to 2002 – examines the dynamic behavior of domestic inflation and interest rates in the context of the currency board. In the absence of nominal exchange rate flexibility, other variables adjusted to ensure equilibria in both the goods and services and the capital markets. Following a similar dynamic to the one analyzed under the Convertibility Plan, and taking into consideration the finding that Argentine prices adjust to keep the real exchange rate constant in the long run, the current strategy of keeping a “competitive exchange rate” has an obvious downside: the impossibility to control inflation.

Keywords: PPP, UIP, Cointegration, Argentina, Convertibility Plan

Introduction

After the hyperinflationary processes of 1989 and 1991, Argentina engaged in an exchange rate-based economic stabilization strategy that fixed the national currency – the peso – to the dollar, known as the *Convertibility Plan*.

The logic behind convertibility was that, since the nominal exchange rate was fixed at a parity of 1:1, Argentina’s inflation rate should decrease and converge to the United States’ level, assuming that purchasing power parity (PPP) would hold. The counter-inflationary benefits of fixing the exchange rate to the dollar would come from the reputation of the U.S. Federal Reserve in pursuing a sound monetary policy. Along with price stabilization, the currency board would promote the convergence of domestic interest rates to the reserve currency levels. During an adverse shock, or with an overvalued peso, imports would exceed exports. With the Central Bank simply converting the extra pesos into dollars, the money supply would decrease. Liquidity constraints would drive interest rates higher. A higher interest rate would dampen investment and economic activity, until imports dropped. High domestic interest rates would attract capital inflows and thereby ease the contraction of the economy, making the local currency more attractive again. In the most extreme scenario, the Central Bank was expected to allow a massive conversion of pesos to dollars (until the monetary base was zero) rather than breaking the peg.

The Convertibility scheme lasted approximately 10 years, collapsing in 2002 and triggering economic mayhem with severe consequences for Argentina's economic, political, and social situation.

The bulk of the literature finds the causes of the Convertibility crisis mainly in the overvaluation of exchange rates, fiscal indiscipline, and the mounting foreign debt, which were inconsistent with a sustainable fixed exchange rate. This article explores a different, complementary explanation, building on the *political economy* line of analysis that focuses on the behavior of economic actors: in a nutshell, it tries to show that it was the counter-cyclical role of domestic interest rates, added to investors' asymmetric information, which finally broke the Plan. In other words, the high interest rates would ultimately have changed the investors' confidence in the commitment and strength of policymakers to continue with an unpopular recessionary and deflationary adjustment.

The next section presents the main characteristics of the Plan. It is followed by the empirical analysis of the time series properties of price, inflation, and interest rate differentials, using univariate and multivariate techniques. We review the PPP and uncovered interest parity (UIP) hypotheses using two approaches: testing for unit roots and testing for a cointegrating vector between these variables, in order to analyze the adjustment of domestic variables to U.S. levels. To complement the empirical findings we further test for Granger causality in order to check the economic consistency of the results obtained. Inflation differentials play an important role in altering international competitiveness and interest rate differentials.

The analysis leads to a final section of conclusions, which support the basic premise of this article, and to an epilogue, highlighting the severe economic consequences of the Convertibility Plan for Argentina, in terms of output loss and increase in unemployment, among other variables. This article intends to shed some light on some of the issues linked to inflation and interest rate behavior that could help policy makers understand the past and, learning from it, avoid or anticipate the likelihood of future crises. In the current context of a depreciating dollar, Argentina is trying to keep a competitive exchange rate which implies constant interventions in the foreign exchange market. Lessons learned from the past warn us that prices and the real economy will receive the pressure of the adjustment.

An overview of Argentina's Convertibility Plan and its crisis

The economic and political conditions that led to what is referred to as the *Convertibility Decade* in Argentina were created during the eighties, marked by high foreign debt, a persistent foreign exchange imbalance, high inflation levels, stagnant industrial production, and deep economic recession. All these factors led to a series of hyperinflation processes in 1989 and 1990, increasing the levels of social conflict and the lack of confidence in the economic institutions and in the state in general. These were the determinant factors for the introduction of the reforms that radically transformed the domestic economy of Argentina. These transformations were the backdrop for the setting of a fixed exchange rate system (currency board) in order to tie the hands of the monetary authorities and set clear rules that would restore investors' confidence.

As from 1991, the measures adopted by Argentina's new administration under President Carlos Menem followed the prevailing trend in most of Latin America during that period, known as the *Washington Consensus*.¹ Argentina was particularly radical in applying these measures as well as in reducing state functions. These were framed in the Convertibility Plan, the term used to refer not only to the exchange rate stabilization tool but also to the structural reforms undertaken throughout the decade.

Essentially, Convertibility was a price level stabilization policy backed by a law², adopting a currency board pegging the peso to the U.S. dollar at a 1:1 rate. Later on, in 1992, another law³ was passed reforming the Central Bank, requiring that this institution hold reserves equal to no less than 80% of the monetary base, whereas the remaining 20% could be covered with government securities. The main purpose of the currency board is to increase the credibility of the government's commitment to a fixed exchange rate, as it creates a direct relationship between the behavior of the monetary base and the evolution of international reserves. In other words, in a context of free capital mobility and a fixed exchange rate, monetary policy becomes fully endogenous (passive). Furthermore, a currency board scheme such as the one adopted under the Convertibility Law also eliminates the possibility of monetizing the fiscal deficit, as explicit limits are set to the accumulation of government securities by

the monetary authorities. The fiscal deficit can then be financed by placing debt securities in domestic or international markets.⁴

The Convertibility Law expressly prohibited contracts with price indexation clauses so as to freeze nominal wages and curb any sort of inflationary pressure.⁵ Also, new rules for the Central Bank strongly restricted its capacity to act as lender of last resort, while setting high reserve requirements to prevent liquidity problems.

The Convertibility Plan turned Argentina into one of the emblematic examples of “pro-market” economic reforms. Even though some reforms were already past their initial stage prior to the adoption of the currency board (favoring its implementation), the new economic model was not consolidated until the currency peg took place. The structural reforms were an ambitious plan providing for deregulation and privatization of the economy, trade and capital liberalization, and the transformation of the financial sector. As Dagum (2008) pointed out that the rigor and inexorability of the inflationary phenomenon in Latin America has spurred non-conformist intellectuals and governments to adopt a wide variety of policies, some of them quite unorthodox.

The strategy that was supposed to bring Argentina into the club of developed countries, transforming not only the economy but also society as a whole, massively collapsed after a decade in January 2002 leaving more than 50% of the population below the poverty line in a context of recession, deflation, and social, political, and financial chaos. This led to the breakdown of the banking system and a devaluation which allowed the currency to float from the original 1 peso per U.S. dollar, reaching 3.90 pesos to the dollar in June 2002.

There is no consensus on the main causes of the crisis. Simplifying, the extensive literature on this period can be divided into two main streams: those focusing on the intrinsic characteristics of a fixed exchange rate regime and those highlighting the inappropriateness of the fiscal policy. There is also a third line, stressing the role of expectations and institutions within a political economy framework.

As for the literature emphasizing the characteristics of the exchange rate regime to explain the crisis of the Convertibility Plan, Feldstein (2002) argued that the fixed exchange rate and the consequent overvaluation of the peso made it impossible to achieve competitiveness. It is important to remember that the Convertibility Law did not allow the government to use monetary policy mechanisms such as currency devaluation. Frenkel (2002) highlighted the strength of the dollar (and therefore the peso) at the time, which, compounded with the sharp devaluation of the Brazilian real, contributed to the decline of competitiveness of tradable sectors. This led to a drop in investment and, ultimately, a throbbing depression.

Some analysts have indicated that the choice of exchange rate regimes is to be based on the *optimal currency area* (OCA) in order to be successful. This theory, pioneered by Mundell (1961), relates the choice of regime to the country’s trade links, size, openness, and the characteristics of the shocks to which the economy is subject. According to these criteria, the choice of a dollar peg would have been the wrong one for Argentina.⁶

The negative consequences of international financial integration are pointed out by Bayoumi and Rose (1993), Fischer (2001), and Obstfeld and Taylor (2002). Some of the issues raised include the impossible trinity and the balance sheet problems that the Argentine economy confronted during the Convertibility years. This led, as Fanelli (2002) pointed out, to a very heavy foreign debt, both private and public, and to increased financial fragility, related especially to currency and maturity mismatches between liabilities and assets. Roubini (2001) and De la Torre, Yeyati, and Schmukler (2002) have argued that Convertibility did not prevent the balance-sheet effects of a real exchange rate adjustment. The adjustment happened through deflation and unemployment, therefore limiting the repayment capacity of debtors with earnings from the non-tradable sector. In the same line, Edwards & Lefort (2002) and Hausmann & Velasco (2002) pointed out the inconsistencies between the exchange rate system (currency board) and the financial system, which made the banks prone to runs.

A second main strand of the literature, following the “first generation” models of currency crises, emphasizes the inconsistency between the fixed exchange rate and the fiscal policy pursued by the government, along with the perverse debt dynamic generated.⁷ As an example of this position, Lavagna

(2003) argued that the plan was not sustainable from a macroeconomic perspective, considering the fiscal imbalance, the realignment of the exchange rate in other countries – particularly in Brazil, Argentina's main trade partner – and the fact that the opening of commerce was not conducive for the improvement of Argentina's productive sectors. The Convertibility model was, in his view, held in place artificially by resorting to external debt.

Finally, a last large strand of literature has its basis in *second generation models*, considering that the fundamentals *per se* were not the key drivers of the crisis. In fact, expectations of devaluation might induce policy change (typically an increase in the interest rate), making the crisis self-validating. These models allow for multiple equilibria, and a crisis can occur, even though economic fundamentals do not change, simply because private agents expect it. This position can be found in Calvo, Izquierdo, and Talvi (2002) and in Galiani, Heymann, and Tomassi (2002). The latter, for example, explain that the dynamics of both fiscal accounts and the real exchange rate can be understood considering the expectations of domestic and foreign agents on the possible trajectories of the Argentine economy. Convertibility (and structural reforms) played an important role, beyond that of a nominal anchor, in the formation of these expectations. These authors view the crisis as a consequence of the frustration of the expectations created by Argentina's economic performance over most of the 1990s. Public and private debt and spending were based on the outlook for future GDP and export growth. The shocks that impacted the economy caused the perceptions of permanent income to be revised, affecting agents' capacity to meet their contractual obligations.

Galiani, et al. (2003) addressed the Convertibility crisis by raising the issue of how and why agents behaved in a way that produced such a terrible outcome. They maintain that Convertibility went much beyond its function as nominal anchor since Argentina was looking for a growth model. Agents could maintain the belief that an economy with considerable resources, after reforming its policies and solving the high inflation problem, would allow residents to sustain high spending. However, as time passed without signs of recovery, expectations and plans were revised downward. At the same time, the political scene changed considerably. In brief, the bet on rapid growth was not successful and the disappointment of expectations fueled the end of the Convertibility plan.

According to Heymann (1990) the imperfect knowledge about the functioning of the economy and the possible effects of alternative policies may also have implications for policy choices, even in the absence of signaling or under opposite possibilities. Some authors suggest improving the treatment of agents' anticipations since they might be imperfectly rational and/or mismeasured. This suggests that a complementary role should be attributed to the treatment of expectation-based errors in testing the purchasing power parity and uncovered interest parity.

This is the point of departure of the empirical analysis presented in the following section.

Empirical analysis

Purchasing power parity (PPP) is a central concept in monetary economics.⁸ In flexible exchange rate regimes, PPP plays an important role in the determination of the exchange rate, while in fixed exchange rates regimes it is central for price level determination. This key feature, the determination of the price level, is the interest of this article since the objective of the Convertibility Plan was to stabilize Argentine prices reducing inflation to U.S. levels. By having monetary policy tied to that of the U.S., the government argued that a credible hard peg would rapidly anchor expectations and would provide some of the necessary conditions for achieving a balanced growth path.

PPP states that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries, so that a unit of currency of a country will have the same purchasing power in a foreign country. Uncovered interest parity (UIP) is the financial market analogue to PPP. UIP states that the interest differential is on average equal to the ex post exchange rate change: if the interest rate in the domestic country is higher than the similar interest rate in the foreign country, then investors will expect the domestic exchange rate to depreciate (Flood & Rose, 2001).

The following empirical analysis examines the time series properties of price levels, inflation, and interest rates, as well as price, inflation, and interest rate differentials, using univariate and multivariate

techniques, based on monthly data from March 1991 to December 2001.⁹ The PPP and UIP hypotheses are reviewed using two approaches: testing for unit roots and testing for a cointegrating vector between these variables, in order to analyze the adjustment of domestic variables to U.S. levels. To complement the empirical findings, we further test for Granger causality in order to check the economic consistency of the results obtained.

To test if the currency board achieved its objective to anchor inflation expectations in order to bring inflation down to U.S. levels, this article focuses on the validity of PPP theory. Since PPP is based on traded goods, we used producer price indices as suggested by Taylor & Taylor (2004). Production prices contain more manufactured tradable goods, while consumer price indices tend to reflect the prices of more non-tradables, such as many services. There is no just one single variable that arbitrageurs use to compare their prospective return at home and abroad in the literature. We choose Argentina money market rates due to availability and because they are used by international investors and major financial institutions. However, for the U.S., we consider the T-bills to be the more appropriate measure.

The following series are used in this article:

PPIa = Producer price index for Argentina

PPIus = Producer price index for U.S.

mma = Argentine money market interest rate as a proxy for short-term interest rate in annual terms

tbus = 3 month U.S. T-bills in annual terms

The following computations have been performed to transform and scale the data. All variables, apart from the interest rates (which appear in fractions) are in natural logarithms. Accordingly, inflation rates for both countries are computed from the first differences of the natural log of the corresponding price indices:

$i = 1 + mma/12$, monthly return of the Argentine interest rate;

$i^* = 1 + tbus/12$, monthly return of the U.S. interest rate;

$p = \ln(PPIa)$, natural logarithm of producer prices in Argentina;

$p^* = \ln(PPIus)$, natural logarithm of the producer price index in U.S.;

$\pi = p_t - p_{t-1}$, inflation in Argentina;

$\pi^* = p_t^* - p_{t-1}^*$, inflation in the U.S.

The final full set of variables consists of p for domestic producer prices, p^* for foreign producer prices, i domestic nominal short-term interest rate, i^* for foreign nominal short-term interest rate, π for domestic inflation rate, and π^* for foreign inflation rate.

Analyzing convergence involves testing the relevant time series for a unit root, or stationarity, and testing for cointegration.¹⁰ In this article, we test if Argentine price levels, inflation, and interest rate converged to U.S. levels during the Convertibility period. If a series has no unit roots, it is characterized as stationary, and therefore exhibits mean reversion, meaning that it fluctuates around a constant long-run mean. Also, the absence of unit roots implies that the series has a finite variance that does not depend on time and that the effects of shocks dissipate over time. The failure to reject the unit root null hypothesis (or the rejection of the null of stationarity) implies that shocks affecting the Argentine price, inflation, and interest rates have a persistent effect and do not revert to long-run equilibrium.

Univariate Unit Root Tests of Parities and Stationarity

The following figures allow for a visual analysis of price, inflation, and interest rates differential between Argentina and the U.S.A. As for producer price differentials (see Figure 1), there are large deviations from the sample mean and the possibility of a trend and a break around the end of 1996. On the other hand, the inflation differential appears stationary fluctuating around its mean (see Figure 2). However, there might be structural breaks in mid-1996 and at the beginning of 2001, so formal tests are

needed to confirm stationarity. Figure 3 shows the high volatility of the nominal interest rate differential especially at the beginning (until March 1992) and at the end (from February 2001) of the Convertibility Plan. This may reflect the lack of credibility of investors at the initial stages and before the devaluation when there were clear signs of great social, economic, and political uncertainty in Argentina. Spikes are present during the crisis with the European Monetary System and the Mexican crisis. From 1996 until at least mid-2000, there is a tranquil period with very low spread.

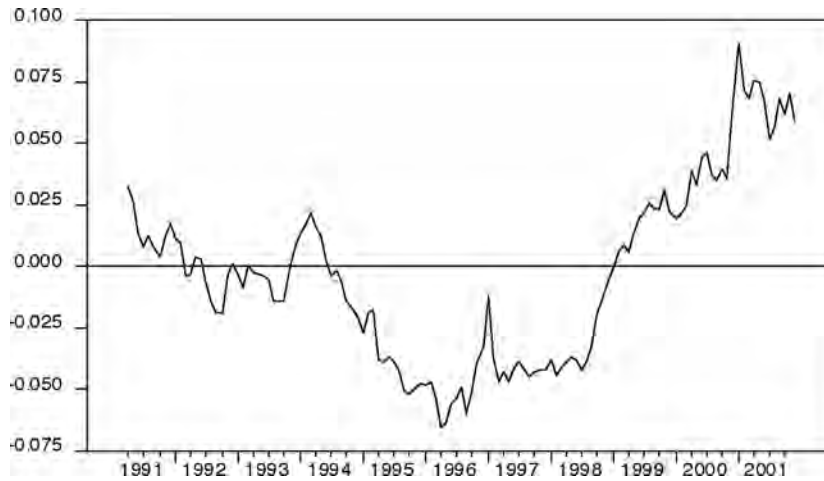


Figure 1. Producer Price Index differential between Argentina and the U.S. PPI.

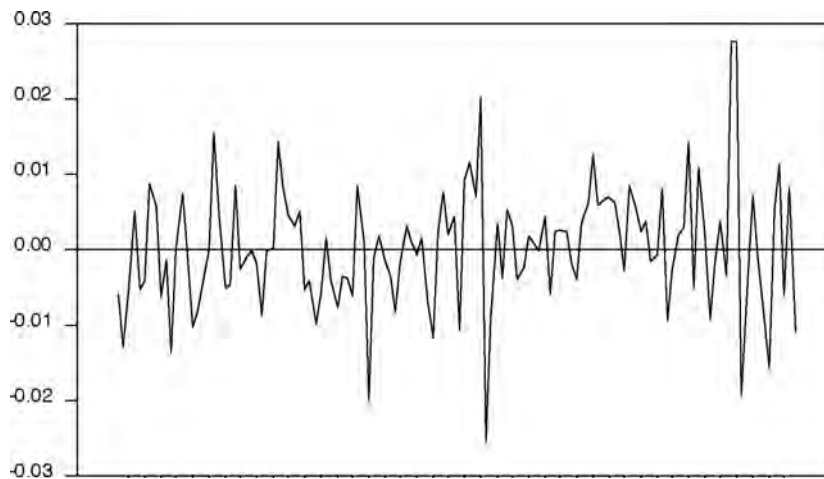


Figure 2. Inflation Differential between Argentina and the U.S.

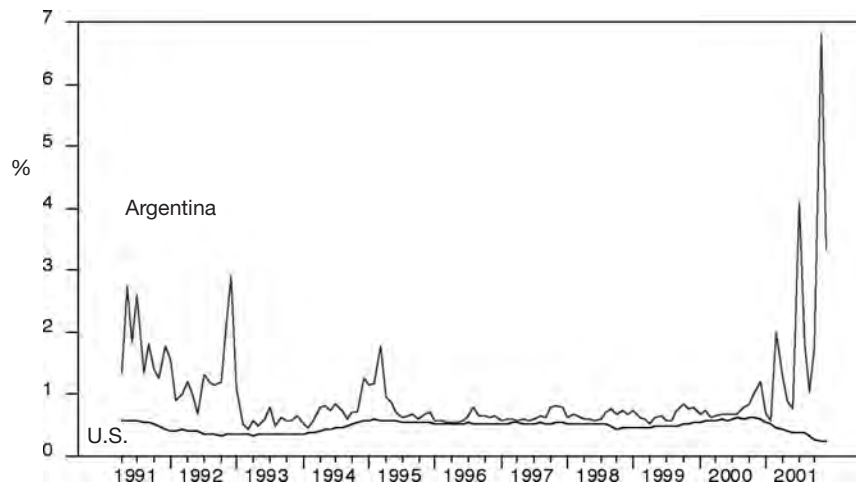


Figure 3. Nominal interest rate comparison between Argentina and the U.S.

The visual inspection is not conclusive, but seems to suggest that only the inflation differential is stationary. In order to verify this conclusion, we have used the Augmented Dickey Fuller (ADF) statistic to test the price, inflation, and interest rate differential for unit roots. In fact, three versions of the ADF test were performed to formally test for stationarity of the price, inflation and interest differentials and to decide which deterministic components need to be included: a constant term and/or a trend in the regression (see Table 1).

Table 1
ADF Tests H_0 : Series has a Unit Root

ADF Tests	With constant and trend ^{*1}	With constant, no trend	No constant, no trend	Result ^{*2}
Price differential	-1.24251	-0.52160	-0.59368	Fail to reject
Inflation differential	n.a.	<i>-5.06635</i>	n.a.	Rejected
Interest rate differential	0.78239	-0.13968	0.46446	Fail to reject
Interest rate differential ^{*3}	n.a.	<i>-3.5166</i>	n.a.	Rejected

Statistically significant values in italics: ^{*1} Critical value at 1% = -3.410. ^{*2} Reported by RATS arauto procedure. ^{*3} Sub-period March 1991 to December 2000.

According to these tests, we can reject the unit root hypothesis for the inflation differential (with a constant term) and the interest rate differential (with a constant term) during the sub period ending December, 2000; while the unit root test for the interest rate differential for the whole Convertibility period is not rejected as is the unit root test for the price differential.

Crowder and Phengpis (2007) show that ADF tests have low power and may lead to distortions in the presence of large and negative moving average (MA) terms in the data generating process. Based on the local Generalized Least Squares (GLS) trending method, the Ng-Perron tests are found empirically to have greater power and much less size distortion than the ADF tests. Perron (1997) developed a procedure to test for unit roots that endogenously searches for structural breaks. These additional unit root tests, presented in Table 2, respond to the possibility of lack of power of the standard ADF test, which in our case might be magnified due to the small sample, and to the possibility of structural breaks in the data.

From the tests performed, and taking into account the small sample correction (129 observations) for the critical values, we can conclude that price and interest rate differentials for the whole Convertibility period contain a unit root. On the other hand, we can reject unambiguously the unit root null hypothesis for inflation differential in the whole period and interest rate differential in the sub-period ending in December 2000.

Table 2
Additional Unit Root Tests H_0 : Series has Unit Roots

	ADF ^{*1}	Ng-Perron Test ^{*2}	Schmidt-Phillips ^{*3}	Lagragian Multiplier ^{*7} (LM) Test1	Result
Price differential ^{*4}	-0.852	-0.885	-1.34	-3.853	Cannot reject unit root
Inflation differential ^{*5}	<i>-10.139</i>	<i>-10.174</i>	<i>-9.43</i>	<i>-7.738</i>	Unit root rejected
Interest rate differential ^{*6}	-0.456	-2.860	-4.30	-3.126	Cannot reject unit root
Interest rate differential until end of 2000	-4.469	-4.469	-4.75	-6.72	Unit root rejected

Statistically significant values in italics: ^{*1} Critical values at 1% = -3.46, 5% = -2.88, and 10% = 2.57. ^{*2} Estimated with RATS program, based on Ng and Perron (2001) paper. Critical values for 100 observations at 1% = -3.482, 5% = -2.884, and 10% = -2.579. ^{*3} Critical values for 100 observations at 5% = -3.06. ^{*4} Possible break at December 1996 included in Perron Test. ^{*5} Possible break at October 2000 included in Perron Test. ^{*6} Possible break in series at February 2001 included in Perron Test. ^{*7} See footnote 11.

The test for stationarity investigates whether a variable can be assumed stationary by itself by testing whether the variable in question corresponds to a unit vector in the cointegration space. H_0 is that the variable is stationary. Then, failing to reject the null hypothesis implies that the variable in question can be considered $I(0)$.

Table 3
Univariate Test for Stationarity: LR-Test, χ^2 (p -r) H_0 : Series is Stationary

	Argentine PPI	Argentine interest rate	U.S. PPI	U.S. interest rate	χ^2
Stationarity	34.401 <i>(0.000)</i>	9.092 <i>(0.028)</i>	30.989 <i>(0.0007)</i>	30.466 <i>(0.000)</i>	7.815
Results	H_0 rejected	H_0 rejected	H_0 rejected	H_0 rejected	

Statistically significant values in italics

As can be seen in Table 3, none of the variables are stationary over the sample period (p -values in parentheses). We can therefore reject the null hypothesis of stationarity for all the variables in the model, reinforcing the results obtained in the univariate unit root tests. The test for stationarity differs from the ADF test performed above, because it has stationarity as the null hypothesis given the cointegration space, while the univariate ADF test has non-stationarity as the null hypothesis. The purpose of these tests is also to gain insights about the long-run relation, which will be used for the identification of the long-run multivariate structure. The system of x_t is chosen because of its economic relevance, not its time series properties. There can be both $I(0)$ and $I(1)$ variables.

Multivariate Tests for Stationarity

In the literature, it is well known that unit root tests have low power and may fail to reject the unit root hypothesis in a near unit root economic time series (Assaf, 2006). To avoid this problem, we have further tested the null hypothesis that the series is stationary around its mean. The test for stationarity investigates whether a variable can be assumed stationary by testing whether it corresponds to a unit vector in the cointegration space.

This article is interested in the long-run relationships from sectoral VAR (Juselius, 1992; Sekine, 2001) rather than other possible applications like impulse response analysis, identification of the full matrix (Π), or short-run dynamics.

As can be seen in Table 4, hypotheses 1 and 2 test a Fisher parity condition for Argentina and the U.S.A respectively. Hypotheses 3 and 4 test nominal and real interest rate differentials. All the p -values are less than 5% critical value, therefore rejecting the hypothesis of stationarity.¹²

Table 4
Tests of Linear Restrictions on the Cointegrating Vector β

	Argentine inflation	Argentine interest rate	U.S. inflation	U.S. interest rate	χ^2	P -value
H_1	-1	1	0	0	34.472	(0.000)
H_2	0	0	-1	1	30.958	(0.000)
H_3	0	1	0	-1	23.883	(0.000)
H_4	-1	1	1	-1	34.584	(0.000)
H_5	<i>1</i>	<i>0</i>	<i>-1</i>	<i>0</i>	<i>1.177</i>	<i>(0.278)</i>

Statistically significant values in italics

Hypothesis number 5 tests inflation differential, and in this case we failed to reject the hypothesis of stationarity. The tests for stationarity confirm the results of the univariate unit root tests: only the inflation differential is stationary – it does not contain a unit root. Departures from the real interest parity during the period can be explained by deviations in UIP, mainly due to friction in the asset market, and not necessarily in the goods market. Similar evidence is reported by Ferreira (2004) when estimating real interest differentials between Argentina and Brazil. Nominal interest rates are more volatile than inflation differentials.

A large real interest differential between Argentina and the U.S.A. imposes heavy costs on Argentina's economy because of interest payments on public, domestic, and foreign debt. Understanding the complex dynamic between inflation and the interest rate differential that took place under the Convertibility Plan is essential to learn from the past and design future macroeconomic policy accordingly. The 1:1 exchange rate made Argentine products expensive; therefore falling inflation was needed. The government prediction was that productivity would rise faster than wages, permitting Argentine inflation to decline relative to U.S. levels. Since the productivity surge happened only in the period 1992-1993, in order to keep the peso's peg to the dollar, the Argentine government tightened macroeconomic policy, pushing the economy into recession.¹³ Without the productivity recovery, deflation needed a recession, making the adjustment process slow and costly in terms of output and employment. This deflationary process created an important financial vulnerability: it eroded debtor capacity to pay.¹⁴

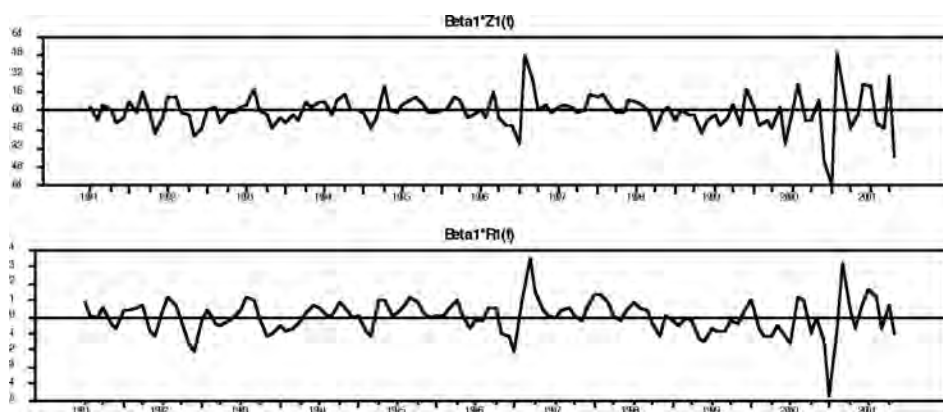


Figure 4. Cointegration vector for inflation differential.

Stationarity of Inflation Differential

Finally, to assure that our model is well specified, we check the assumptions of the VAR model and also test for structural stability of the parameters obtained.

H_0 : Exhibits mean reversion in that it fluctuates around a constant long-run mean: $E(y_t) = \text{constant}$ for all t . A graphical inspection of the cointegrating residuals from the maximum likelihood estimation of the cointegration relation between inflation rates appears to be $I(0)$, supporting the identification of the long-run equilibrium.

Figure 4 shows the equilibrium error of the inflation differential long-run relation as a function of short-run dynamics and the deterministic component (constant term, no trend) $\beta' x_t$, whereas $\beta' R_{1t}$ is corrected for the short-run effects and shows the disequilibrium error (the similarity between both shows stationarity and no presence of I_2). The relation looks stationary apart from outliers at January 1997 and January 2001. After 2001 the relation looks less stable. We also note that there is no trend in the cointegration relation. β is restricted (see H_5 from Table 4 above).

H_0 : Has a finite variance that is time-invariant: $\text{Var}(A_t) = \text{constant}$ for all t . VAR analysis assumes parameters that are time invariant. The null hypothesis of constant parameters is tested using Hansen and Johansen (1999) recursive statistics based on the eigenvalues encountered in the estimation procedure. The null hypothesis is rejected if the difference between the eigenvalues based on a sub-sample chosen and the full sample exceeds the critical value. Table 5 shows that we fail to reject the null hypothesis of

constant since the value of the re-estimation (Re-est. column) is smaller than the critical values (even more after short run – SR – effects corrections).

Table 5
Parameter Constancy Test

	Re-est	Fixed SR	Crit 5%	Crit 1%
logit (lambda_1)	1.23	1.12	1.36	1.63

The statistical inference requires constant parameters over the full period. We estimated the transformed eigenvalues using backward recursive maximum likelihood tests using Hansen and Johansen's (1999) procedure that employs the time paths of the eigenvalues to analyze the stability of the model.

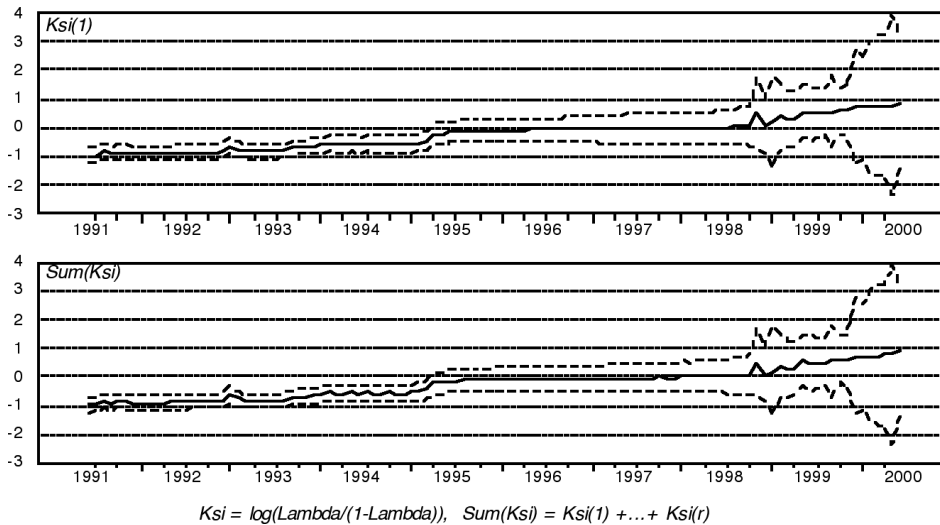


Figure 5. Backward recursive estimation transformed eigenvalues.

We note in Figure 5 that the eigenvalues show signs of constancy over the base sample period but problems appear at the end of the period from 1999 onwards (sign of asymmetry of distribution). This asymmetry could have been anticipating a regime switch (the possibility of a future devaluation). The asymmetry captured especially after mid-1999 is consistent with recent developments in the theory of imperfect capital markets where risk perceptions may vary with interest rates. This feature opens an interesting line for future research.

We use recursive estimation with base sample June 1992 to December 1997 to examine the stability at the end of the Convertibility period (see Figure 6).

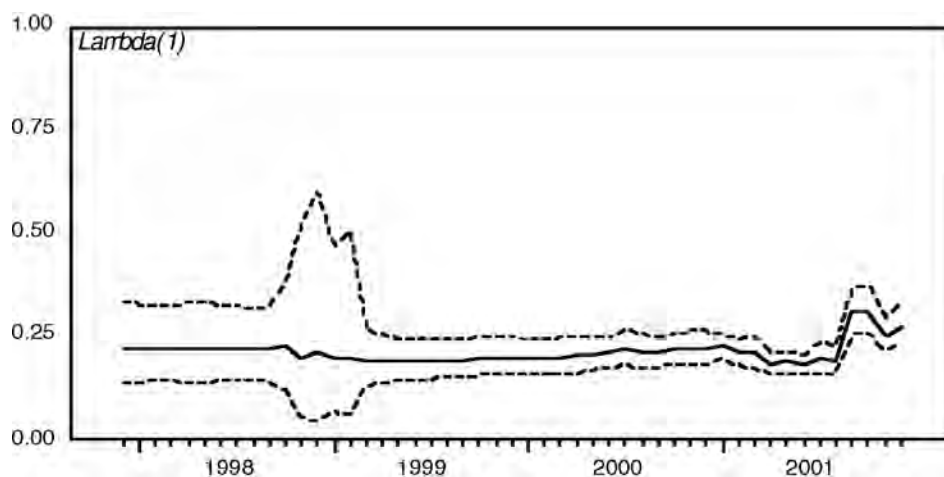


Figure 6. Recursive eigenvalues plot.

The plot of lambda shows some instability at the end of 1998 and beginning of 1999 and again a small break at the beginning of 2001 (the last year of the Convertibility Plan) which has not been fully dealt with by the inclusion of dummies however it does not justify including a shift dummy.¹⁵ Apart from these, the estimate shows very little time dependency.

To complement the analysis of the eigenvalues performed before, a recursive statistics test on β has been performed following Hansen and Johansen (1999). The test of constancy of β is a test of the following hypothesis:

$$H_{\beta\tau} : \tilde{\beta} \in sp(\beta_{(t)}) \quad t_1 = T_0, \dots, T.$$

in which $\tilde{\beta}$ a known matrix. The test statistic is asymptotically distributed as χ^2 with $(p - r)$ r degrees of freedom. The null hypothesis of constant β is rejected if the value is higher than the critical value. Figure 7 reinforces the findings of parameter constancy until 2000 and Figure 8 shows some instability in 2001. Finally, the correlogram in Figure 9 (H_0 : ACF PACF Correlograms $Cov(y_t, y_{t+k}) = \text{constant for all } t \text{ and all } k \neq 0$) has only an initial spike and then dies out confirming that the inflation differential is stationary.

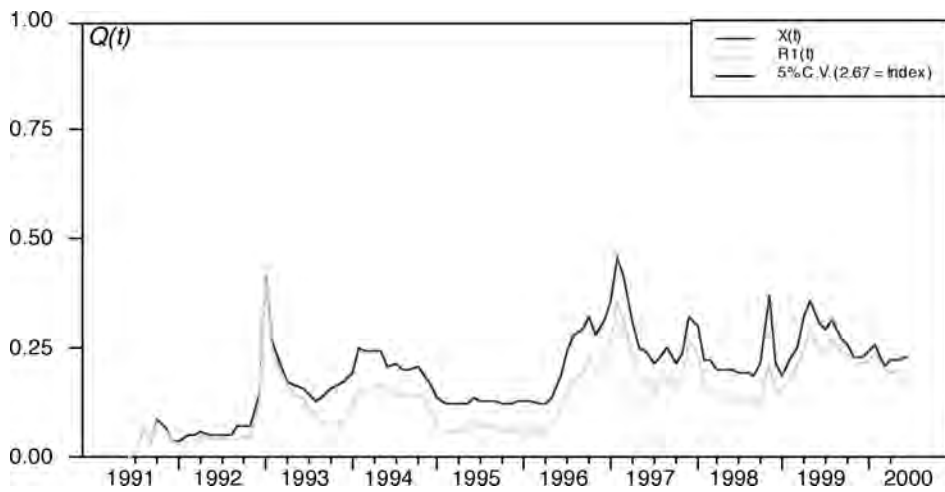


Figure 7. Constancy of beta backward recursive estimation 1991-2000.

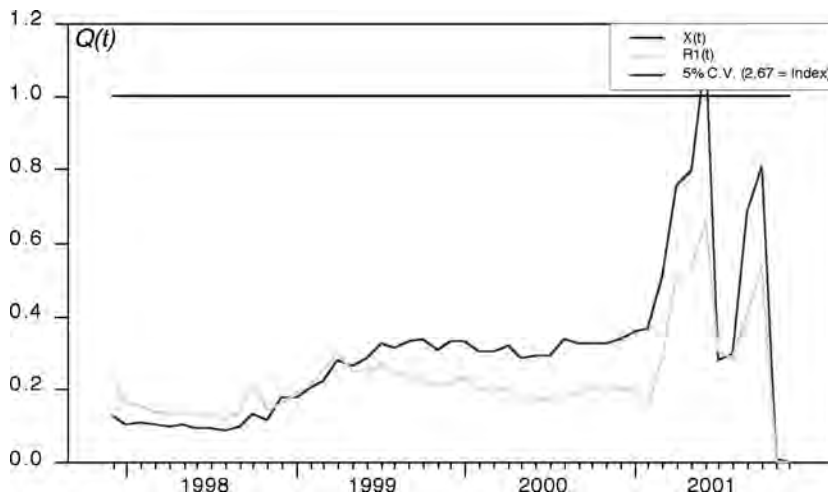


Figure 8. Constancy of beta recursive estimation period 1998-2001.

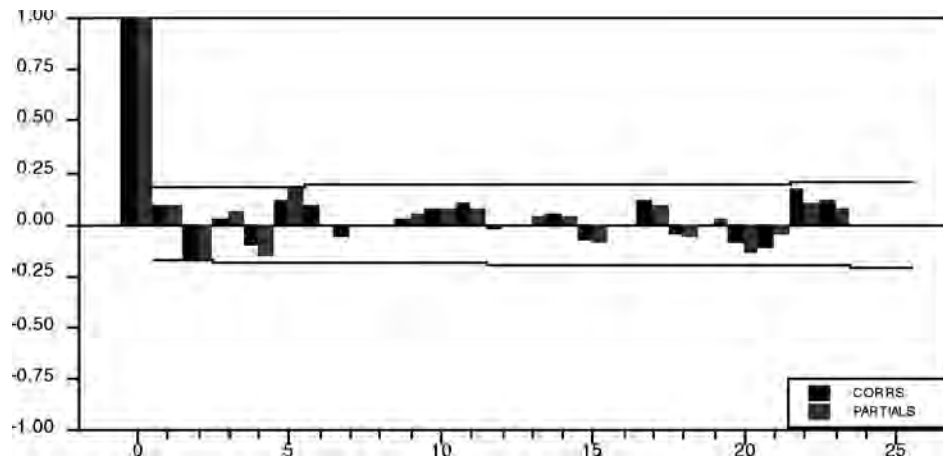


Figure 9. ACF and PACF of inflation differential.

Short Run Dynamics: Granger Causality

Multivariate Granger causality developed by Dolado and Lutkepohl (1996) is appropriate to analyze the relationship between two or more variables in both levels and first differences abstracting from the problem of nonstationary data. Granger causality tests are used to reinforce the results obtained and to point out potential interrelationships among the variables in the system. The objective is to examine the dynamics and alternative channels of transmission between inflation and interest rates (see Table 6).

Table 6
Granger Causality F-Tests

F-Test (sign.)	Argentine inflation	Argentine interest rate	U.S. inflation	U.S. interest rate
Argentine inflation	1.0077 (0.407)	0.7335 (0.571)	0.3827 (0.821)	1.2417 (0.298)
Argentine interest rate	0.8372 (0.504)	<i>17.9285</i> (<i>0.000</i>)	1.4640 (0.218)	<i>4.3517</i> (<i>0.003</i>)
U.S. inflation	<i>3.2178</i> (<i>0.0155</i>)	<i>4.1852</i> (<i>0.003</i>)	<i>4.9504</i> (<i>0.0011</i>)	1.0603 (0.380)
U.S. interest rate	1.5804 (0.185)	0.4871 (0.745)	2.3586 (0.058)	<i>680.6877</i> (<i>0.000</i>)

Statistically significant values in italics

It is interesting to note that at conventional significance levels, Argentine inflation is only Granger caused by U.S. inflation as the weak form of PPP suggested. No inflation inertia is present since the inflation rate is not correlated with itself (past inflation values). This finding supports the success of the Convertibility scheme as an anchor for inflation, since in the literature, inflation is usually the result of economic agents' inflation expectations – typically shaped by past experiences. By giving up monetary policy flexibility, the newly achieved credibility should have worked as a signal for the revision of expectations. Argentine and U.S. interest rates do not Granger cause Argentine inflation. On the other hand, Argentine money market interest rate is Granger caused by itself showing that it is endogenous. Interestingly, Argentine money market rates do depend on U.S. inflation, but not on the U.S. interest rate, as the failure to support UIP may suggest. The gain in credibility given by the currency board argument is weaker from this point of view.

As expected, none of the U.S. variables is Granger caused by the Argentine variables since Argentina is a small country and does not affect U.S. inflation or interest rates (except for a small and probable sample correlation on Argentine interest rates). On the other hand, through the Convertibility scheme, the U.S. variables did influence the Argentine magnitudes.

Conclusions

The major findings from the previous analysis are the following:

1. During the period under consideration, the inflation rate differential with a constant term is stationary (does not possess a unit root). Therefore, Argentine inflation adjusted to U.S. inflation levels, but since the mean differential is non-zero, there was still real exchange rate misalignment (using PPP as a benchmark and given that the nominal exchange rate was fixed at 1). The success of the Convertibility Plan to lower inflation can be a consequence of the increased capital mobility and of the convergence towards sustainable purchasing power parity levels. Trade and financial liberalization (along with globalization) allowed the entrance of cheaper imports that stabilized inflation, but created the constant need to finance the current account deficit.

2. There has been no convergence between Argentine and U.S. interest rates when tested for the whole period of the Convertibility Plan March 1991 to December 2001, with Argentina's levels always higher. Therefore, even though Argentine inflation expectations were brought down by the Convertibility Plan, the same logic of the currency board implied that under negative shocks interest rates had to adjust. The Mexican crisis is an example of how domestic interest rates were increased in order to defend the peso. To a certain degree, the currency board necessitated non convergence. The 1990s were a period characterized by many adverse external shocks, like the Mexican, Asian, Russian, and Brazilian crises which may explain non-convergence without implying that high domestic interest rates played a role in the demise of the Convertibility Plan in 2002.

3. In contrast, a related and interesting result is that the unit root test is rejected for the sub-period April 1991 to December 2000 around a positive mean difference. Intuitively, this difference may arise from a country specific risk premium and/or from the already mentioned short lived peso defenses that soon reverted back to the mean. This result is consistent with the findings of Carvalho, Sachsida, Loureiro, and Moreira (2004), who maintain that rational expectations and UIP hold during the period January 1991 to December 1998. Additionally, Ferreira and Leon-Ledesma (2007) find that the real interest parity hypothesis holds for Argentina during the period January 1992 to August 2003. They find a rapid adjustment of 0.78 months, towards a positive real interest rate differential.

4. We believe that the behavior of interest rates during 2001 is a key feature to understand the devaluation of 2002. Stiglitz (1999) supports the theory that steep increases in interest rates may lead investors to expect lower returns, since they believe that in this context, the probability of default is high. If we do not assume rational expectations, and allow for imperfect information, the risk perceptions will change with the interest rate itself as tested in Kraay (2003) for several industrial and developing countries. He maintains that high interest rate defenses do not always work under currency speculative attacks since when domestic interest rates surpass a certain threshold, there is the possibility for multiple equilibria. We do find evidence of non-constant parameters after 2001.

5. The idea that 2001 was characterized by asymmetric information or misperceptions has important policy implications, since only unanticipated policies would be effective.³ The capital flight started in March 2001. The freeze of the deposits⁴ of December, 2001 which tried to stop the bank run, was held for a long period without resolution accompanied by political uncertainty. Therefore, large and informed depositors were able to withdraw leaving only small depositors in the banking system as Perry and Servén (2002) point out. This empirical feature of our data is at odds with the prevailing new classical paradigm, which assumes rational behavior as how economic agents form expectations. Following Dagum (2008), it is clear that it is more fruitful to make a classification of the variables analyzed not only according to their nature but also due to their circumstances. The nature is determined by its causes, their direction, intensity, and interaction. Its circumstances are determined by the economic and social structure within which the causes or variables interact.

Epilogue

In 2001, it became clear that the costs of sustaining the Convertibility Plan were extremely high. The economic vicious circle included depressed economic activity that negatively impacted tax revenues and worsened the fiscal deficit, which in turn eroded debt repayment capacity. The lack of credibility pushed interest rates higher and reduced investment, feeding back to depressed economic activity.

To some extent, there is circularity in the discussion over the interest-rate spread. It could be debated whether the interest-rate spread was high because of default risk or default risk was high because of the interest-rate spread, which supports the possibility of multiple equilibria depending on different interest rate differentials. This circularity shows how expectations and confidence played a role in the demise of the Convertibility Plan that ended up with bank runs and default, regardless of (and maybe worsened by) the fundamentals in the economy.

The deflationary and recessionary adjustment process that took place created high social costs which weakened the government coalition. The confused political environment generated doubts on the political commitment to the Convertibility Plan. According to Hausmann and Velasco (2002) the dilemma the Argentine government was facing was that “at the prevailing real exchange rate even modest growth of 3% could only be achieved at the expense of large current account deficits and rising debt ratios. Argentina thus found itself in a dilemma: if it tried to grow, it risked accumulating debt to the point of insolvency; if it chose to achieve external balance, it would have had to achieve strongly negative growth rates, which would also have imperiled its solvency” (p. 19).

The deflationary adjustment to the external shocks imposed by the hard peg to the dollar (as discussed above) had an effect on debt sustainability perception, through two channels: first, by reducing long-term growth expectations and second, by making the fiscal adjustment more painful as the ratio of revenues to GDP collapsed. In this context, the tax hikes (as the *impuestazo* in 2000) and the expenditure cuts (as during the second half of 2001) aggravated the recession and subsequent social and political tensions.

Since mid-2001, deposits actually left the banking system and headed abroad. In this context, the widening of the interest rate spread with the dollar probably surpassed a credibility threshold and signaled lenders the high probability of default.

Finally, the Convertibility regime collapsed leaving the country in a deep financial crisis. The combination of all the factors mentioned before – confidence crisis due to deterioration of the fundamentals of the economy as well as doubts about the solvency of the country – forced a peso defense that, unlike the response to the Mexican crisis, was unsuccessful. Even though the fundamentals of Argentina have improved from the Convertibility crisis, this study warns us about the perverse dynamics between lack of confidence and foreign exchange intervention.

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Footnotes

1. The main features of the Washington Consensus were the following: fiscal discipline; re-orienting of public spending towards sectors offering high economic returns and a potential for improved income distribution (such as basic health care, basic education, and infrastructure); fiscal reform (to bring down the average tax rate and expand the tax base); liberalization of interest rates; competitive exchange rate; trade liberalization; liberalization of foreign direct investment streams; privatization; financial deregulation (eliminating barriers to the entry and exit of capital); and safeguarding of property rights. For a detailed explanation see Gore (2000).
2. Law 23.928 on the Convertibility of the Austral (Argentina's previous currency).
3. Law 24.144 on the Reform of the Organic Act of the Central Bank of Argentina.
4. In the case of Argentina, in a context of poor development of the domestic capital market and "dollarization" of the financial system, public sector financing was virtually all foreign currency denominated and, to a great extent, obtained in international markets.
5. This curb did not work as an operating restriction, as most credit transactions used dollars as a pattern for future payments (Heymann, 2000).
6. See Levy Yeyati and Sturzenegger (2003) or Perry and Serven (2002) for a detailed discussion.
7. See, among others, Basualdo (2003), Feldstein (2002), Katz (2001), Krueger (2002), Mussa (2002), and Schuler (2002).
8. For a complete survey on PPP literature, see Taylor and Taylor (2004).
9. Monthly data from March 1991 to December 2001 was obtained from IMF's Financial Statistics Database, August 2003. Even though we are aware that empirical tests of long-run relationships require considerable amounts of data, we will only work with 129 observations for Argentina and the United States of America. This limitation is due to structural limits in Argentina, where there was a hyperinflation in 1989 and a devaluation in January 2002, and to the fact that we are interested in the currency board as a stabilization policy during the "Convertibility Decade." The data length limitation is, in any case, shared by many other analyses, e.g., Grigorian, Khachatryan, and Sargsyan (2004) use data from January 1996 to June 2003 to analyze the post-stabilization period in Armenia. Ahlgren, Juselius, and Siliverstovs (2004) also use a span of ten years to analyze inflation dynamics of Estonia and Latvia.
10. The discussion is based on Maddala (1988).
11. Developed by Im and Lee (2001), it is very flexible since it can be applied when a structural break occurs regardless of its number and location. As reported by Im and Lee (2001), the LM test loses little power by controlling for spurious structural breaks when they do not exist. It is a reasonable strategy to control for breaks even when they are only at a suspicious level. Critical values for 100 observations: 1% = -6.21; 5% = -5.55; and 10% = -5.25.
12. Johansen (2000 and 2001) developed a small sample correction for the critical values which is performed by CATS in RATS software.
13. See Feldstein (2002).
14. See Perry and Serven (2002).
15. An additional model was estimated with a shift dummy for the year 2001 but the stability of the parameters did not improve.
16. See Karunaratne (1999) for a theoretical discussion on this issue.
17. Decree 1570/2001.

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