Public debt and real exchange rate dynamics in Argentina under Convertibility

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I. Introduction

This paper builds a simple deterministic dynamic model of Argentina’s Convertibility regime, stressing the importance of downward inflexibility of prices and nominal wages. Given such inflexibility, the model seeks to reflect the inability of the Convertibility regime to facilitate the adjustment of the economy to the two large and permanent adverse shocks that it faced in the second half of the 90s: the increase in risk aversion after the Russian crisis and the real appreciation of the U.S. dollar. This inability allowed the accumulation of macroeconomic imbalances: REER misalignment, explosive growth of public debt and an unprecedented increase in unemployment.

After a brief graphical account of the main facts in section II, section III contains an underdetermined macroeconomic model that may be closed in alternative ways that depend on the Central Bank’s monetary/exchange rate regime. Two polar regimes are considered in this paper: 1) Convertibility and 2) a Pure Float. To highlight the essential elements of a highly dollarized economy, it is assumed that 1) all debt is dollar denominated and is held by foreigners and 2) there is no domestic financial intermediation in either currency. Hence, country risk only impacts on the domestic dollar interest rate and there is no room for the traditional “uncovered interest parity” (cum risk premium) condition. Furthermore, it is assumed that the public debt is much greater than the private debt, so that it is the former that determines the country risk premium. Hence, the country’s (dollar) interest rate varies directly with the stock of (dollar) public debt and a risk aversion parameter. Increases in risk aversion have the effect of increasing the dollar budget deficit through its effect on interest payments and its contractionary effect on output and tax collection.

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1 Comments by participants in the Argentine Central Bank’s seminar and in the Universidad Torcuato Di Tella are gratefully acknowledged. Special thanks are due to George McCandless for helpful comments and suggestions.
The fiscal authorities are either assumed to be completely myopic and passive or their stabilization policies to be completely ineffective due to the ambiguity of the effects of the instruments at their disposal. In particular, increases in taxes or reductions in transfers or expenditures have contractionary effects on output that tend to cancel their direct effects on the primary surplus. Hence, attention is focused on the effects of changes in endogenous variables (as the stock of public debt or the REER) or of exogenous variables (as risk aversion or trade partners’ bilateral real exchange rates with the U.S.A.) on the budget deficit. One of the key dynamic equations under both regimes is the government budget constraint, which gives the evolution of the public debt.

Aggregate demand is quite conventional, with private absorption depending on disposable income, the interest rate and the REER. Aggregate supply is based on a slowly adjusting nominal wage and firms’ mark-up pricing rule. It is assumed that the nominal wage adjusts to the consumer inflation rate (which includes imported inflation) and (a fraction of) the gap between a “required” real wage (that varies inversely with the output gap) and the actual real wage (that varies inversely with the actual REER). And firms’ pricing is a simple mark-up on wage and imported goods costs. Combining these relations gives a “Phillips curve” and the law of motion of the REER in terms of the real wage gap, which is a second key dynamic equation in both regimes.

The model is sufficiently decomposable so that the dynamics of the REER and the public debt may be analyzed per se, giving a long run equilibrium that is a saddle-point under both monetary/exchange rate regimes. The REER varies inversely with Brazil’s nominal exchange rate with the U.S. dollar, which is an exogenous parameter that is taken as representative of the exchange rates of all of Argentina’s trade partners outside of the U.S. dollar area (and which is completely non-forecastable). Hence, real dollar appreciations appear as real depreciations of the Brazilian Real. These have the effect of increasing the (dollar) nominal budget deficit because they reduce the dollar value of the (peso) primary surplus. Given Brazil’s real exchange rate, real peso appreciations have the effect of increasing the dollar deficit because they have a contractionary effect on output and tax collection.

The private sector only has domestic (base) money and dollar assets in its portfolio and the demand for domestic money (expressed in dollars) is assumed to vary inversely with the expected rate of nominal depreciation of the peso, which by perfect foresight is equal to the actual rate of depreciation. Hence, increases in the rate of depreciation generate portfolio shifts from the
domestic currency to dollar assets. The money market equilibrium is a third crucial dynamic equation with a trivial solution in the case of Convertibility.

Under Convertibility, the nominal exchange rate is always fixed at unity. Hence, the dollar value of the money stock stays constant and all private wealth accumulation is accomplished through the purchase of dollar assets. Also, changes in the REER are solely produced by changes in the foreign price level (which boil down to changes in the Brazilian nominal exchange rate) or in the domestic price level. Under a Pure Float, the nominal exchange rate varies continuously according to its rate of depreciation and may also jump. Hence, under a Pure Float discrete changes in exogenous variables such as the rate of monetary expansion, the risk premium, or the Brazilian nominal exchange rate may generate jumps in the domestic nominal exchange rate that make the REER jump onto the new (post-shock) saddle-path. Under Convertibility this can only happen if there is so much wage and price flexibility that the price level can jump downwards. Since this is excluded by assumption, the bottom line is that large shocks (or recurring smaller shocks) cannot be accommodated timely under Convertibility.

Different models of Convertibility may be extracted from this deterministic framework. The one most appealing to the author in terms of realism is simply a model with explosive dynamics because the economy has no way of accessing the paths that lead to long run equilibrium. Under this interpretation economic agents are quite myopic and mechanically follow a pattern of behavior that takes them along a “bubble” that must eventually burst. But this “bubble” is not the type of bubble included in perfect foresight models since there is no transversality condition that constrains the economy to eventually reach the saddle-path.

A different model of Convertibility that is consistent with a perfect foresight assumption is one in which it is assumed that all economic agents believe that if the debt level reaches a certain exogenous threshold, there will be a sudden stop in foreign deficit financing, the government will exit Convertibility through Full Dollarization and this put the economy on the saddle-path, either because there is a devaluation prior to swapping the outstanding pesos for the Central Bank’s international reserves or because (very unrealistically) there is an automatic achievement of downward wage and price flexibility as a consequence of Full Dollarization. In the first interpretation, even if the economy reaches the new saddle-path or the long run equilibrium, if there is a new set of adverse shocks the unstable dynamics.
The fundamental assumption is that, short of full dollarization, either the nominal wage or the price level (or both) cannot jump down to rapidly adjust the REER upward if the peso is overvalued, even when the required real wage is lower than the actual real wage. This poses no constraint on the gradual movement of wages and prices: it is only the finite instantaneous reductions in wages or prices that are ruled out. Hence, under Convertibility the economy cannot access the saddle-path that leads to the long run equilibrium and must follow a divergent path with growing public debt (due to deficit financing) and a growing REER (due to domestic price deflation). If the exogenous real depreciation of the Real (real Dollar appreciation) is sufficiently large (or there is a succession of such shocks), the domestic deflation is more than compensated so that the actual REER tends to decrease over (finite lapses of) time and both variables (public debt and REER) evolve in a direction which is the opposite of what the long run equilibrium requires. In the Pure Float model, the economy automatically jumps onto the saddle-path by virtue of the nominal depreciation of the peso even in the presence of nominal downward flexibility of wages and prices.

II. A brief review of the Convertibility experience

Argentina introduced Convertibility in April 1991 after two hyperinflationary episodes that virtually wiped out its financial system and that resulted from the use of monetary alchemy for dealing with fiscal imbalances. It can be said that the main ingredients of Convertibility were 1) the fixed exchange rate with the dollar, 2) the full backing of the Central Bank’s monetary base with international reserves along with relatively high capital and liquidity requirements for banks, and 3) the complete disregard for the build-up of currency mismatches in the non-financial sectors. This combination produced a very “hard peg” which withstood contagion from various financial crises (Mexico 1995, Asia 1997). But the chain of events over the last few years has shown that this very resilience was its major flaw, for it facilitated the accumulation of extremely large macroeconomic imbalances. These imbalances (exchange rate misalignment, explosive public debt growth, unprecedented unemployment and underemployment rates, liability dollarization) could not have grown as much under any other monetary arrangement except full dollarization.
It has been customary to put the blame for Argentina’s present plight on the inconsistency of its fiscal policies with the chosen monetary/exchange rate regime (Mussa (2002)). Argentina has traditionally found it difficult to have sound fiscal policies and the 90s was no exception. The monetary straightjacket had no significant effect in assuring fiscal discipline as there were liquid capital markets readily available to finance both current deficits and new public debt that was issued to settle claims on the public sector determined by court decisions. The Convertibility regime made the fiscally loose policies have the greatest effect on output, debt growth and financial system growth while the country was still in the favorable phase of the cycle. This “success” tended to cloud policymakers’ (and the public’s) perceptions with respect to the sustainability of the regime and downplay the growing vulnerability of the economy to a change in the external environment.

The (federal government) public debt to GDP ratio increased from 29% in end-1993 (when the Brady deal was implemented) to 38% in end-1998 (shortly after the beginning of the present depression) and to 51% in end-2001. Though the last jump can be to some extent attributed to the adverse effects of the deepening recession on tax collection, the first jump can only be attributed to lack of fiscal (including judicial) prudence.

Clearly, if Argentina’s government had been much more prudent on the fiscal side its debt would have increased only slightly (or not at all) and the story could have been very different. But was it reasonable or prudent to assume that this would be so when crucial decisions were made on the permanence of the exchange rate regime after it had completed its role of anchoring high-inflation expectations? When considering the convenience of an exchange rate regime it is necessary to bear in mind the characteristics of the country’s institutions and leadership. The fact that Argentina has traditionally found it difficult to sustain prudent fiscal policies and flexible labor institutions should have been a key consideration for exiting early from Convertibility. The Tequila crisis was probably the best opportunity Argentina had for an early exit, but when it became clear that the government could resist the attack on the currency and the banking system (with some financial help from the IMF) the experience had the unfortunate consequence of reaffirming the government’s view that success was basically a matter of sticking to the hard peg with sufficient firmness.

However, the main thrust of the policies implemented in the aftermath of the Tequilla crisis had dangerous components that were akin to playing “Russian
roulette”: under certain states of nature Convertibility would be a great success, but under other states of nature it could only end catastrophically. Among these components one should certainly include the tolerance towards 1) the build-up of public debt, 2) the increasing REER misalignment, 3) the build-up of enormous currency mismatches in the non-financial sectors of the economy and 4) the stubbornly high unemployment and underemployment rates. Paradoxically, along with this tolerance for risk there were also prudential policies in the financial sector that could be considered conservative, such as the high reserve and capital requirements for banks, if it were not for the extremely vulnerable macroeconomic environment in which banks were operating.

Unfortunately, “nature” did not favor Argentina’s bet. In the second half of the nineties two adverse shocks were particularly severe and lasting: the increase in risk aversion as a consequence of the Russian crisis and moratorium and the increasing real appreciation of the dollar. First, the Russian crisis in August 1998 radically changed international investors’ assessment of risk in emerging market bonds (as well as in sub-investment grade corporate bonds). The Argentine government was significantly indebted by then and 93% of its debt was denominated in foreign currency. Also, Argentina’s public sector’s reliance on internal transfers to service its debt implied greater reliance on growth for debt sustainability than in the case of other Latin American governments. Furthermore, Argentina’s export base is comparatively small (less than 10% of GDP). These facts imply that adverse shocks such as the increase in risk aversion should generate a relatively large increase in the long run equilibrium real effective exchange rate (REER) of Argentina, so that whatever real exchange rate misalignment there already was dramatically increased.

This increase took place when the actual REER had been going in the opposite direction (and was to continue to so in the following years). The fixed exchange rate against the dollar, which strongly appreciated in real terms against all other currencies since mid-1995, along with insufficient

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2 It is important to bear in mind that the public sector in Argentina does not have any comparable direct source of foreign exchange as Chile with copper or Mexico, Ecuador and Venezuela with oil. Therefore, the Argentine government has an important internal transfer problem in having to tax a private sector that has predominantly peso denominated incomes in order to service its dollar denominated debts.

compensating deflation in Argentina presumably due to downward wage and price inflexibility, generated a real appreciation of the peso against all significant trade partners except the U.S. But the U.S. was the destiny of less than 15% of Argentina’s non-commodity exports. The growth of trade with Brazil promoted by the MERCOSUR agreement, along with the real appreciation of Brazil’s currency in the aftermath of the Real Plan, alleviated the effects of the strong dollar for about three years, but when Brazil finally devalued (only five months after the Russian crisis) the full strength of the peso appreciation was felt on competitiveness, output and employment.

At that time, there could hardly be a doubt that exit from Convertibility was absolutely necessary, given the macro imbalances that had accumulated. Some circles believed that full dollarization was the way to exit without pain. Indeed, the Convertibility regime had gradually evolved around the idea that full dollarization was the safety valve if policy consistency was not achieved. Others believed that devaluation was a better exit even if it necessarily implied great costs. Consistent with its past strategies, the government doubled its bet once more, announcing immediately after the Brazilian devaluation that it would seek full dollarization under the sponsorship of the U.S. government. But after losing precious time, this project aborted, along with President Menem’s project of mustering support for a third consecutive presidential period by means of a second constitutional reform. When, at the end of 1999, the new administration of President De la Rúa came to office it tried to stick to Convertibility by raising taxes, as cutting government expenditures did not muster political support. But this thwarted an insinuation of recovery, leading to a change of finance minister. But this was of no avail. A run on the banking system and on the currency started. Even after the government was excluded from the international capital markets it clinged desperately to Convertibility. After zigzagging with widely different policies during nine more months (including the contingent introduction of the euro into Convertibility and the “zero-deficit policy”), it finally introduced severe restrictions on deposit withdrawals which further exacerbated the political and social climate, forcing the President to resign.

A timely regime shift towards a flexible exchange rate policy was discarded in Argentina for many reasons. First among these is the strong anti-inflation bias that prevailed after the hyperinflationary episodes of more than a decade ago and the fear of returning to a high inflation environment. Second, the Brady arrangement in 1993 had left Argentina with a relatively high Dollar-denominated public debt and since then the government kept issuing
predominantly foreign-denominated debt to both external and domestic creditors. Thus, there was the fear that a flexible exchange rate would generate public sector insolvency. Third, the Central Bank played to the tune of the official myth that the regime was to last forever by doing nothing to prevent the rapid increase in dollar credits that were a consequence (but also a cause) of the dollarization of deposits. Since banks tended to avoid currency mismatches they used dollar deposits to grant dollar loans. The dollarization of deposits was itself generated both by the lack of credibility of the permanence of the regime and the high dollar interest rates that were offered. The currency mismatches of the non-financial sectors of the economy generated the fear that a devaluation would wreck the financial system. Finally, as usually happens with prolonged real appreciations, there was the satisfaction of many of those remaining employed of being able to live above long-run sustainable levels as long as there was foreign credit available. The imbalances that were so clearly being built up were largely ignored by leading circles both domestically and in the international community. Paradoxically, even many of those business sectors that were being directly affected by the real peso appreciation preferred to look for very imperfect substitutes to a change in the monetary and exchange rate regime. All these factors made the timely exit from Convertibility virtually impossible.

III. A brief graphical account of the Argentine economy during the 90s

This section gives a brief account of the facts that this paper intends to explore. The selection has no intention of being exhaustive. For example, no account is given of the very strong increase in investment during the booming years of the 90s, of the structural reforms related to the privatization of many government activities, of the banking system, etc.

The first graph shows a textbook account of what one may expect from an extended fixed exchange rate regime: a GDP that is very volatile, with accelerated growth in the expansion phase and a protracted contraction when the capital inflow falters and then stops.

The following graph bears witness to the anxiety of investors in government bonds, as the public debt to GDP ratio grew in a seemingly explosive way. The fact that more than 90% of the public debt was in foreign currency in country where the public sector has no direct source of foreign exchange and
where there is increasing evidence of currency misalignment makes this trend much more explosive.

The third graph shows that since the Russian crisis in 1998 the average EMBI spread faced by Argentina tended to increase pari passu with the debt to GDP ratio. This of course generated increasing domestic interest rates, and especially in real terms after a steady deflationary process began. These very high real interest rates had strong contractionary effects on investment, durables consumption and output once the adverse phase of the cycle began.

The fourth graph highlights the fact that during the post-Russian crisis period while the public debt increased explosively, the REER was steadily falling (i.e. the peso was appreciating in real terms). This helped to increase the real exchange rate misalignment. But it is only a part of the story because, as will be stressed in the model below the long run equilibrium REER was going in the opposite direction. The same can be said about the long run equilibrium public debt to GDP ratio, which was decreasing.

The fifth graph shows the evolution of the federal fiscal deficit as a ratio of GDP and the next one shows the main components of that deficit: the primary surplus and the interest payments. Except for the aftermath of the Tequila crisis in 1996, the primary surplus was positive and increased until 1999, year in which it recovered its pre-Tequila crisis level. But by then the interest payments were rapidly increasing and the recession was undermining the tax collection.

The seventh graph shows the consolidated public expenditures in terms of GDP. This graph is important for having a global and balanced view because during the 90s there were important reallocations of functions between the federal and the provincial governments, the latter taking responsibility for segments of health and education services that had previously been at the federal level. After the peak in 1997 it stayed broadly within the 30-32% level but surpassed 33% in 1999 and 2000, after the economy was hit by the Russian and Brazilian crises.

The eighth graph shows the current account and the capital and financial accounts of the balance of payments in terms of GDP. Except 1995 (the year of the Tequila crisis), the capital inflows were above 3% of GDP until the year 2000, peaking around 6% of GDP in 1998. The following graph shows the share that the non-financial public sector had in these capital inflows. Between
1995 and 2000 that share was always above 50% and reached peaks of more
than 115% in 1995 and almost 100% in 2000. It is clear that the public sector
was a major source of foreign financing for the economy.

The following three graphs concern the REER. The first of these gives a long
term view, and shows that since 1960 there have been three large real
appreciations in Argentina. The second of these is the famous “tablita”
experience of Martínez de Hoz, based on financial deregulation and an active
crawling peg that was meant to achieve disinflation, ending with a banking
and currency crisis. The third one is the long appreciation of the 90s.

The next graph combines the Federal Reserves’ Real Broad Dollar Index
(which starts in 1973 and is inverted so that an appreciation of the dollar is a
downward move) and Argentina’s REER. The graph shows that during
Argentina’s last two appreciation cycles, the last phase before the bust
coincides with a protracted dollar appreciation.

The long REER series involves Argentina’s 6 main trade partners and has
fixed weights, thus under-representing the growing importance of Brazil and
other Latin American countries as trade partners. The third REER graph
shows a much broader version (26 trade partners) with changing weights. As
one would expect, it depicts a more pronounced real appreciation during the
90s than the other series, since more weight is given to Argentina’s Latin
American neighbors that had increasing trade shares (partly as a result of the
MERCOSUR customs union) and significantly depreciating currencies in the
period after the Russian crisis.

The following two graphs (13 and 14) show the effects of Argentina’s opening
up to trade in the 90s and the increasing share of MERCOSUR in that trade.
Exports only started to increase significantly in 1994. However, After the
Russian and Brazilian shocks exports were unable to recover the upward trend
and the share of MERCOSUR declined. And imports, after peaking in 1998
dropped very significantly.

Graphs 15 and 16 show developments in the labor market. The first one shows
that although the employment rate (as percentage of total population) stayed
between 34 and 38 percent during the period 1982-2001 it had two big dips in
1995-6 and in 2001. This is not the whole story, however, because much of
the action during the 90s had to do with how “fully” employed were those that
were “employed”. Remember that the definition of “employed” is having
worked at least one hour (for pay) in the week of the household survey. If instead one considers “fully employed” those that worked at least 18 hours in the week and adds those who worked less than 18 hours to the “unemployed”, one can see a remarkable increase in the portion of the population who worked less than 18 hours per week and an equally remarkable decline of those who worked more.\(^4\)

The next graph looks at the unemployment picture (as percentage of the labor force, which includes all employed and unemployed workers). The unemployment rate increased steadily since 1993, reaching a peak during the Tequila crisis (of more than 18%) and thereafter stayed at very high levels (of more than 13%), and started to increase again after the Russian and Brazilian crises. The lower curve shows the fraction of the labor force that worked less than 18 hours per week. This fraction increases throughout the whole period but the trend seems to increase somewhat during the 90s. Adding these two one obtains the upper curve, which shows that the fraction of the labor force that works less than 18 hours per week reached almost 27% of the labor force in October 2001.

One would expect that with such high unemployment there would be considerable flexibility in nominal wages. The next couple of graphs show that, quite remarkably, the formal sector of the economy has distinctly increasing nominal wages at least until the second quarter of 2000 (2 years into the recession). These figures arise from the contributions to the national pension system, which comprises all sectors of the economy and all geographical jurisdictions. The lower graph on that page shows that they account for more than 4.5 million jobs and, furthermore, that these did not significantly decrease during the period so that the increase in remuneration cannot be caused by composition effects.

Furthermore, if one takes into account that throughout much of the period there was CPI deflation, as is shown in the following graph it is readily seen that real wages in the formal sector were steadily increasing, when the situation clearly called for a reduction.

\(^4\) One should take these graphs with some care because, not having the hourly distribution of the employed for the whole period they were constructed using the hourly distribution of a certain year for which data was available. The distribution may have changed during the period so there is probably some bias. However, the broad picture would probably not change much.
The final graph shows that although Argentina faced a terms of trade shock in the aftermath of the Asian crisis, starting from rather high levels, by the end of 2001 the reduction had been recovered. Hence the shock did not have the lasting influence that the risk aversion and REER shocks had. But it did add to the strains the economy faced in the wake of the Russian crisis.
Employment, Full-employment and Under-employment (% Population)

Unemployment and Underemployment Rates (<18 hours worked in week)(% labor force)

- Employment rate (% Pop)
- Full employment rate (>18 hs.)(%Pop)
- Unemp + Underemp (<18 hs.) (%Pop)

- Unemployment rate (% labor force)
- Unemployment+Underemployment (<18 hs)
- Underemployment rate (<18 hs)
CPI Inflation 1993-2000
(YoY)

Terms of Trade
MA(6)
IV. The model

1. Aggregate demand

Take a country that specializes in the production of an exportable good that is an imperfect substitute for foreign goods and uses an imported good for domestic private absorption. Goods market equilibrium is given by

\[ Y = a(r, e)[Y(1- t) + T] + X(e) - en(e)Y + G, \]

\[ a_r < 0, \ a_e > 0, \ X' > 0, \ n' < 0 \]

where \( Y \) is real output, \( a(.) \) is private absorption per unit of disposable income, \( X \) is exports, \( n \) is imports per unit of output (measured in foreign currency), \( e \) is the real effective exchange rate (REER), \( t \) is the average tax rate, \( T \) is public sector transfers to the private sector, and \( G \) is government expenditure. Private absorption varies negatively with the real interest rate \( r \) through the demand for durable consumption goods and investment goods, positively with the REER \( e \) through substitution effects in consumption and investment demand\(^5\), and positively (and linear homogeneously) with a simplified version of disposable income \( Y(1-t) + T \).\(^6\) It is assumed that exports vary positively

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\(^5\) It would be quite straightforward to modify the model to include a non-tradable sector and the assumption that the country is a price taker in the tradable sector. The one sector model is preferred because of its notational simplicity. Also, building from micro-foundations seems to be a feasible (but arduous) task and could be the subject of future research using “new open economy macroeconomics”, as in McCallum and Nelson (1999), or McCallum (2001). Cfr. also the survey in Lane (1999).

\(^6\) Absorption could be decomposed into domestic and imported components. For example, in the case of consumption (and ignoring variables other than \( e \)) we could have \( C(e) = C_d(e) + eC_m(e) \), where \( C_d \) and \( C_m \) are consumption of domestic and imported goods, respectively, and \( C_d' > 0 \) and \( C_m' < 0 \). Then \( C'(e) > 0 \) if and only if the demand for imports is either elastic or not too inelastic.

\(^7\) In Argentina, pensions and other transfers to the private sector accounted for 47% of consolidated primary expenditure in the year 2000.

\(^8\) Notice that if one defines disposable income as that income that could potentially be consumed (absorbed) while maintaining wealth intact (Sargent (1979), p. 17) it could more correctly be defined as \( Y(1-t)+T-\delta M/P \) (where \( \delta \) is the rate of nominal depreciation) which differs from the simple version because it subtracts the “inflation tax”. Under Convertibility the rate of nominal depreciation is zero, so the more correct version would not change anything. In the Pure Float regime that will be defined below, minor adjustments would have to be made to use this theoretically more satisfactory version of disposable income but
with the real exchange rate (both in terms of the domestic currency $X(e)$ and in terms of foreign currency $X(e)/e$), and that imports measured in domestic currency ($en(e)Y$) vary negatively with the REER and positively (and linear homogeneously) with output. 9 Thus, from (1), aggregate demand for output is given by

\[
Y = \frac{G + X(e) + a(r,e)T}{1 - t a(r,e) + en(e)} \equiv Y(r, e; t, T, G)
\]

where the signs below the variables denote the signs of the corresponding partial derivatives. Hence, aggregate demand varies negatively with $r$ and $t$ and positively with $e$, $T$ and $G$.

2. The real effective exchange rate

The real effective exchange rate (REER) is defined as

\[
e \equiv \frac{E P^*}{P},
\]

where $E$ is the nominal exchange rate with the Dollar (Pesos per Dollar), $P$ is the domestic price level and $P^*$ is the foreign price level. $P^*$ is defined as a weighted average of the price levels of the country’s trade partners. For simplicity, the Brazilian Real is used as representative of the currencies of all other trade partners outside of the U.S. dollar area. 10

\[
P^* = \left( \frac{P_{US}^*}{(1-\lambda)} \right) \left( \frac{P_{BR}}{\rho} \right)^{1-\lambda}.
\]

nothing essential would change in the model. This is why the simpler version was preferred.  
9 Since the focus is on the medium and long run, this paper avoids modeling the short run negative effect that a sudden increase in the real exchange rate often has on output in less developed countries (cfr. Krugman and Taylor (1975)).  
10 Brazil’s Real and other Latin American currencies are very important in Argentina’s non-commodity trade. Argentina’s main non-commodity export destinies (and shares) in 2000 were Brazil (30%), Euroland (21%), Chile, Uruguay and Paraguay (together 14%), U.S.A. (13%), with a share of 22% for all other destinies (the largest of which was Mexico, with a 2,5% share).
Here \( \rho \) is the Real/Dollar exchange rate, \( \lambda \) is Brazil’s share in Argentine trade and \( P^*_\text{US} \) and \( P^*_\text{BR} \) are the price levels in the U.S. and Brazil, respectively. Average foreign inflation is thus

\[
\dot{\pi}^* \equiv \frac{P^*/P^*}{\rho} = (1-\lambda)\pi^*_\text{US} + \lambda(\pi^*_\text{BR} - \rho/\rho)
\]

where a dot over a variable denotes a time derivative and \( \pi^*_\text{US} \) and \( \pi^*_\text{BR} \) are the inflation rates of the U.S.A. and Brazil, respectively. Notice that if foreign prices pass-through to domestic prices to any extent, the depreciation of the Real generates deflationary pressure in Argentine price dynamics.

From the definition of \( e \) and (4), the REER varies in time according to

\[
\frac{\dot{e}}{e} = \delta + \pi^* - \pi = \delta - \pi + (1-\lambda)\pi^*_\text{US} + \lambda(\pi^*_\text{BR} - \rho/\rho),
\]

where

\[
\delta \equiv \frac{E}{E}, \text{ and } \pi \equiv \frac{P}{P}
\]

are the (expected and actual) rate of nominal depreciation of the peso against the dollar and the (expected and actual) rate of inflation of domestic goods, respectively. Given the domestic and international rates of inflation and the Peso’s rate of nominal depreciation, the real rate of Peso appreciation (a reduction in \( e \)) is higher the higher is the rate of depreciation of the Brazilian currency vis a vis the dollar.\(^{11}\)

To simplify notation, in the rest of this paper the individual foreign price levels are fixed at unity. Thus, individual foreign inflation rates are zero. Also, to reduce the dimensionality of the dynamical system \( \rho \) is taken as an exogenous parameter that may now and then unexpectedly shift, instead of changing continuously. These shifts affect the REER through the average foreign price level (3) which conveniently reduces to

\(^{11}\) Since mid-1995 the dollar started to strengthen very significantly against almost every other currency. However, due to the Brazilian currency’s real appreciation in the aftermath of the Real Plan and the increasing relevance of Argentina’s trade with Brazil as a consequence of the MERCOSUR customs union, the strength of the dollar appreciation fully impacted the Argentine economy when Brazil devalued in January 1999. Argentina’s currency appreciated 22% in real terms since July 1995 and 50% since April 1991 when Convertibility began. The real appreciation was particularly strong in 1991 because during this year inflation in Argentina, though declining, was still high. Cfr. Escudé, Gabrielli and Cohen Sabban (2001).
\[ P^* = \rho^{-\lambda}. \]

Hence, the final expressions for the REER and its rate of change are:

\[ e \equiv E/(P\rho^{\lambda}) \]

\[ e/e = \delta - \pi. \]

3. The supply side

Assume that firms price domestic goods with a simple mark-up rule over wage and imported input costs:

\[ P = cW^b(EP^*)^{1-b} \quad (0<b<1) \]

(where \( c \) may include both a mark-up and a productivity factor). Since workers consume both domestic and imported goods, the relevant price index for adjusting wages is the consumer price index:

\[ Q \equiv P^{1-\beta}(EP^*)^\beta = P(EP^*/P)^\beta = Pe^\beta, \quad (0<\beta<1) \]

where \( \beta \) is the share of imported goods in the consumer price index. Define the real wage as \( w \equiv W/Q \). Introducing (9) in (10) gives the following inverse relation between the real wage and the REER: \(^{12}\)

\[ w = c^{-1/b}e^{-[1-b(1-\beta)]/b}. \]

This equation reflects the fact that a real appreciation of the Peso (a fall in \( e \)), by reducing the relative cost of imported goods, reduces the cost of the consumption basket and hence increases workers’ overall purchasing power.

Assume that workers bargain for a “required real wage” \( (w^R) \) that is less (greater) than the natural, full employment level \( \omega_0 \) whenever there is a negative (positive) output gap (and corresponding positive unemployment (overemployment)):

\(^{12}\) Notice that \( 1-b(1-\beta) \) is positive since both \( b \) and \( 1-\beta \) are less than 1.
\begin{equation}
\omega^R = \omega_0 + \omega(Y - \bar{Y}),
\end{equation}

where \(\bar{Y}\) is the output rate that corresponds to a “natural” level of unemployment. Define the “real wage gap”, or simply \(\text{Gap}\), as the difference between the required real wage and the actual real wage \(\text{Gap} \equiv (\omega^R - \omega)\). Using (11) and (12) gives

\begin{equation}
\text{Gap}(Y, e) = [\omega_0 + \omega(Y - \bar{Y}) - c^{-1/b} e^{-[1-b(1-\beta)]/b}] + + +
\end{equation}

The real wage gap varies directly with output because a rise in \(Y\) increases the required real wage and varies directly with the REER because a rise in \(e\) decreases the actual real wage by increasing the cost of imported goods.

Assume that workers manage to have firms raise their nominal salary above (below) the expected consumer inflation rate whenever their real wage is below (above) their required real wage, that is whenever there is a positive (negative) \(\text{Gap}\):

\begin{equation}
W/W = Q/Q + \alpha' \text{Gap}(Y,e)
\end{equation}

where \(\alpha'\) is a positive constant. Taking the (right-hand) time derivative in (9) and (10) and using (14), it turns out that the domestic (producer) inflation rate is given by the following “Phillips curve”:

\begin{equation}
\pi = \delta + \alpha \text{Gap}(Y,e),
\end{equation}

where \(\alpha \equiv \alpha' b/[1-b(1-\beta)] > 0\).

Notice that (14) can have two alternative interpretations. If \(W\) is assumed to be continuous it implies that all wage adjustments are smooth, that is, that there cannot be jumps in wages when there are unexpected jumps in exogenous variables that affect the real wage gap. However, if it is merely assumed to be right-continuous \(W\) may have jumps.

Also, notice that (8) implies that if there is convergence to “long run” equilibrium (with an unvarying \(\rho\)), in the “long run” \(\pi\) must be equal to \(\delta\), so that the real wage gap must be zero. Observe, however, that a zero output gap need not be necessarily imposed in the steady state. The output gap will be negative (positive) in the long run (and hence unemployment above (below)
the “natural rate”) whenever firms’ mark-ups \((c)\) and workers’ basic required real wages \((\omega_0)\) are jointly too large (small) with respect to the long run equilibrium REER \((e^*)\) so that
\[
c^{1/b} \omega_0 > (\leq) e^{*(1-b(1-\beta))/b}.
\]

4. The international supply of funds

To simplify and streamline the basic characteristics of the Convertibility period, assume that all non-monetary government debt is dollar-denominated and held by non-residents. Also, assume that the supply curve of funds in the international capital markets is such that (not only the marginal but also) the average interest rate on the stock of government debt is increasing with the level of debt \((B)\) and with the international interest rate cum risk premium \((\theta)\).

\[
(16) \quad r = r(B; \theta).
\]

However, \(B\) cannot grow without bound because when it reaches a certain exogenous threshold \(\overline{B}\) there is a sudden stop in foreign financing which forces the government to take corrective action.

Aggregate demand (2) and the real wage gap (13) can now be expressed as:

\[
(2') \quad Y(e, B; \theta, t, T, G)
\]

\[
(13') \quad \text{Gap}(e, B; \theta, t, T, G).
\]

Furthermore, using (8), (15), and (13’), the REER varies in time according to:

\[
(17) \quad \frac{e}{e} = -\alpha \text{Gap}(e, B; \theta, t, T, G),
\]

increasing (decreasing) whenever the real wage gap is negative (positive), with \(\alpha\) as the speed of adjustment. Notice that, given \(B\), this law of motion for \(e\) is stable. An increase in \(e\) raises the real wage gap (13) directly by

diminishing the actual real wage and indirectly by raising the required real wage through its effect on the output gap. This puts pressure on the nominal wage (14) and (by mark-up pricing) on domestic (producer) inflation (15). And this makes the REER fall, partially correcting the initial increase.

5. Government finances

The government, a consolidation of the non-financial public sector (or simply the “Treasury”) and the Central Bank, can finance its budget deficit by issuing domestic (base) money (M) or Dollar-denominated bonds (B), or by drawing from the international reserves of the Central Bank (R). Its budget constraint is therefore:

\[ M + EB - ER = rEB - P(tY - T - G). \]

Define the Dollar value of the domestic money stock as

\[ m = M/E. \]

Then

\[ m = M/E - \delta m, \]

so dividing the budget constraint through by E and using (2'), (7) and (16) gives:

\[ m + B - R = r(B; \theta)B - [tY(e, B; \theta, G, T, t) - T - G]/(\epsilon \rho \lambda) - \delta m. \]

Let S stand for the government’s primary surplus in Pesos:

\[ S(e, B; \theta, G, T, t) = t Y(e, B; \theta, t, T, G) - T - G. \]

Notice that the qualitative effects of fiscal variables such as t, T and G on the primary surplus are ambiguous, since increases in t and reductions in T and G have contractionary effects on output. This is probably the main reason why the fiscal adjustments that were repeatedly used in Argentina with the purported aim of increasing the government’s ability to service its debt (and strongly advised by the IMF) were complete failures. Partly because of this qualitative indeterminacy, but principally because the focus of this paper is on the monetary and exchange rate aspects of Argentina’s problems during the
Convertibility period, the exogenous fiscal variables will henceforth be omitted.

To simplify notation further, let Def stand for the nominal budget deficit expressed in Dollars:

\[
\text{Def}(e, B; \theta, \rho) \equiv r(B, \theta)B - S(e, B; \theta)/(e^\lambda).
\]

An increase in the debt level B raises the nominal budget deficit both because it increases interest payments and because the consequent increase in the domestic interest rate has a contractionary effect on output which diminishes the government’s primary surplus. On the other hand, the effect of an increase in the REER on the budget deficit is not so clear cut because it increases the Peso primary surplus through the expansionary effect on output but it diminishes the foreign exchange value of the primary surplus. It is assumed that the expansionary effect of e on output and hence on tax collection and the primary surplus predominates over its negative effect through the conversion of the primary surplus to foreign exchange.\(^{14}\) An increase in risk aversion raises the deficit by increasing interest payments and reducing output and tax collection. Finally, a Brazilian devaluation increases the (Dollar) deficit by reducing the Dollar value of the (foreign exchange) primary surplus.

Using (19) and (20), (18) simplifies to:

\[
\text{Def}(e, B; \theta, \rho) - \delta m.
\]

6. Private financial wealth accumulation and the balance of payments

Assume that the private sector only has two financial assets available, domestic money M and Dollar assets abroad F that earn the international

\(^{14}\) This is another instance in which the very short run is avoided. The first impact of any jump in e is to contract the foreign exchange value of the primary surplus, and hence increase the deficit. This is particularly crucial when there’s a large upward jump in e. Escudé (2002) shows, in a simple one period stochastic framework, how an increase in the expected real depreciation can generate a debt crisis.
interest rate (which is assumed to be zero). Thus, in Dollar terms private sector financial wealth \( V \) is defined as\(^{15}\)

\[ (22) \quad V = m + F. \]

The country’s net claims on the rest of the world are therefore \( F + R - B \), so the balance of payments equation is

\[ (23) \quad F + R - B = T(e, B; \theta)/\rho^\lambda - r(B, \theta)B. \]

where \( T \) is the foreign currency value of the trade surplus, defined as:

\[ (24) \quad T(e, B; \theta) \equiv X(e)/e - n(e)Y(e, B; \theta). \]

Here it is assumed that the positive effect of the REER on the foreign currency value of exports, along with its negative effect on unit imports is sufficiently strong that the foreign currency trade balance responds positively to a higher REER.\(^{16}\)

Taking the derivative in (22) and adding the respective sides of the equalities in (21) and (23), gives the private sector’s budget constraint:

\[ (25) \quad V = m + F = T(e, B; \theta)/\rho^\lambda - S(e, B; \theta)/(e\rho^\lambda) - \delta m, \]

\[ + \quad + \quad - \quad + \quad - \quad - \]

\(^{15}\) It would be straightforward to assume that private firms have an external debt \( B_p \) while \( F \) is in the hands of families. Then for the private sector as a whole, \( V = m+F\) - \( B_p \). If one assumes that \( B_p \) is constant, the only change required in the model is to subtract \( r(.)B_p \) from (25) and (26) and to assume that \( r \) is not affected by \( B_p \) (say, because the private debt is insignificant in comparison with the public debt). This procedure is avoided to economize on notation. But the existence of private debt is an important factor in the influence of \( r \) on \( a(.) \) in (1), so it should not be disregarded.

\(^{16}\) Formally, the partial derivative of \( T \) with respect to \( e \) is:

\[ T_e = [(X/e)(\varepsilon_x - 1) + nY(\varepsilon_n - \varepsilon_y)]/e, \]

where \( \varepsilon_x, \varepsilon_n, \) and \( \varepsilon_y \) are the REER elasticities of \( X, n, \) and \( Y, \) respectively. Hence, a necessary and sufficient condition for \( T_e \) to be positive is \( \varepsilon_x - 1 > (enY/X)(\varepsilon_y - \varepsilon_n), \) which is a generalization of the Marshall-Lerner condition. Since it has already been assumed that \( \varepsilon_x - 1 > 0, \) a sufficient condition for \( T_e > 0 \) is \( \varepsilon_n - \varepsilon_y > 0, \) that is, the negative percentage effect of \( e \) on unit imports is larger than its positive percentage effect on output (so that an increase, say, in \( e \) has the effect of reducing the foreign currency value of imports.

31
which, defining private nominal financial savings in foreign currency as

\[ H(e, B; \theta) = T(e, B; \theta) - S(e, B; \theta)/e, \]

\[ \equiv T(e, B; \theta) - S(e, B; \theta)/e, \]

can be expressed more succinctly as\(^{17}\)

\[ V = H(e, B; \theta)/\rho - \delta m. \]  

(26)

7. The private sector’s portfolio balance and the Central Bank’s balance sheet

The private sector holds its financial wealth (V) either in domestic money (M) or in Dollar assets abroad (F) that earn the international interest rate (which is assumed to be zero). Hence, the Dollar return on domestic money is the negative of the Peso’s rate of nominal depreciation (-\(\delta\)), and is the return differential between the two assets available to the private sector. For simplicity the effect of output on (base) money demand is neglected. Thus, equilibrium in the (base) money market is given by

\[ m = l_0 - l_1 \delta. \]  

(27)

On the other hand, the Central Bank’s balance sheet identity is:

\[ R + C/E = m, \]  

(28)

where C represents the Central Bank’s Peso credit to the Treasury. The balance sheet reflects the fact that the Central Bank issues base money either by purchasing foreign exchange, in which case it is backed, or by simply printing currency and handing it over to the Treasury, in which case it lacks backing. It is implicit in (28) that the Central Bank hands over to the Treasury

\(^{17}\) This equation will play a minor role in the dynamic system below, determining the trajectory of V once those of e and B are determined. A somewhat more complicated version of this paper includes the effect of financial wealth in the private absorption per unit of output function a(.). In that case, equation (26), along for the dynamic equations for e and B constitute an indecomposable (3 by 3) dynamical system. Here the simpler version was preferred in order to reduce the dimensionality of the indecomposable subsystem and make two dimensional graphs feasible.
any windfall profits or losses that it may have as a consequence of changes in $E$.

8. The underdetermined dynamical system

For the reader’s convenience the set of 13 independent equations that have so far appeared are gathered below, 7 of which are mere definitions.

1) $\frac{e}{e} = -\alpha \text{Gap}(e, B; \theta)$
   \hspace{1cm} \text{REER dynamics}

2) $m + B - R = \text{Def}(e, B; \theta, \rho) - \delta m$
   \hspace{1cm} \text{Gov. budget constraint}

3) $V = H(e, B; \theta)/\rho^\lambda - \delta m$
   \hspace{1cm} \text{Private sector budget const.}

4) $m = l_0 - l_1 \delta$
   \hspace{1cm} \text{Money market equilibrium}

5) $R + C/E = m$
   \hspace{1cm} \text{C.B. balance sheet}

6) $m \equiv M/E$
   \hspace{1cm} \text{Definition of } m

7) $e \equiv (E/P)\rho^\lambda$
   \hspace{1cm} \text{Definition of } e

8) $\delta \equiv E/E,$
   \hspace{1cm} \text{Definition of } \delta

9) $\pi \equiv P/P$
   \hspace{1cm} \text{Definition of } \pi

10) $V \equiv F + m$
    \hspace{1cm} \text{Definition of } V

11) $P \equiv cW^b(E^{\lambda})^{1-b}$
    \hspace{1cm} \text{Definition of } P

12) $Q = Pe^\beta$
    \hspace{1cm} \text{Consumer price index}

13) $w \equiv W/Q.$
    \hspace{1cm} \text{Definition of } w
There are 12 non-policy endogenous variables: e, B, V, m, F, E, P, W, Q, w, δ, and π, so an additional variable can potentially be endogenously determined. The Central Bank has the three variables M, C, and R from which it can pick the paths of two, and the remaining variable will be endogenous. The rest of the symbols are either exogenous parameters (α, c, b, β, λ, l₀, l₁) or exogenous variables (θ, ρ).

Two basic (and polar) monetary regimes are defined below. First, the Convertibility regime, where the Central Bank adapts the supply of base money so as to maintain a fixed exchange rate with the dollar and abstains from financing the Treasury. Second, a Pure Float exchange rate regime, where the Central Bank has an exogenous rate of monetary expansion and abstains from intervening in the foreign exchange market. Under Convertibility, the Central Bank chooses certain paths of M and C and the path of R is then endogenously determined whereas under a Pure Float the Central Bank chooses the paths of R and M and the path of C is endogenously determined.

9. The Convertibility regime

Under Convertibility the Central Bank supplies the amount of nominal (base) money necessary to keep the nominal exchange rate constant at a given (initial) level and abstains from granting credit to the Treasury:

\[ M = l₀E₀ \]  

(\text{C14})

\[ C = 0. \]  

(\text{C15})

C14) implies (by 6)) that \( m = l₀ \). Inserting this equality in 4) gives \( δ = 0 \), so that by 8) E remains fixed at its initial value \( E₀ \) (which is assumed to be 1, as was the case). C15) indicates that the Central Bank abstains from granting credit to the Treasury. Also, inserting C14) in 5) gives \( R = m \), assuring full backing of the monetary base with international reserves. Hence, \( m, M \) and \( R \) remain fixed at \( l₀ \). Summing up, we have:

\[ \delta = 0, \quad E = 1, \quad M = m = R = l₀. \]  

(29)
The first two equations of the system thus reduce to the following two dimensional dynamical system which gives the paths of e and B:

\[
\begin{align*}
(\text{C1}) \quad e/e &= -\alpha \text{Gap}(e, B; \theta) \\
(\text{C2}) \quad B &= \text{Def}(e, B; \theta, \rho) .
\end{align*}
\]

Notice that, given e, the law of motion of B is unstable. An increase in the public debt has the effect of increasing the budget deficit both directly through interest payments and indirectly through the negative effect that the increase in the interest rate has on the primary surplus. Hence, the government must issue more debt to finance the increased deficit. Given the paths of e, B, and the variables in (29), the paths of the remaining variables can successively be determined.\(^{18}\)

Concentrating on the two dimensional system given by (C1) and (C2), Figure 1 shows that the two lines that represent the locus of points on which e and B (respectively) are constant, have positive slopes. The determinant of the (2 by 2) matrix of the linearized system is:

\[
\det = -\alpha (\text{Gap}_e \text{Def}_B - \text{Def}_e \text{Gap}_B).
\]

This expression can be positive or negative according to which of the two lines (\text{Gap}(.)=0 and \text{Def}(.)=0, respectively) has a more positive slope. Assume, as in Figure 1, that \text{Def}(.)=0 has the greatest slope.\(^{19}\) This means that, starting at the intersection of both lines, if there is an increase in B a higher increase in the REER is necessary to keep the budget balanced than to keep the real wage gap at zero. In the former case, the increase in B raises the budget deficit both directly and indirectly, as pointed out. The compensating increase in e has an expansionary effect on output, and hence on tax collection. In the latter case, the increase in B generates a negative real wage gap (beginning at zero) because by raising the interest rate it contracts output and hence the required

\(^{18}\) More specifically, 7) (with E=1) gives (the path followed by) P, 9) gives \(\pi\), 3) gives V, 10) gives F, 11) gives W, 12) gives Q and 13) gives w. Thus, the paths for all 14 endogenous variables are determined.

\(^{19}\) The slopes of the two isoclines in Figure 1 are \(-\text{Gap}_B/\text{Gap}_e\) and \(-\text{Def}_B/\text{Def}_e\). Hence the determinant is negative if and only if the slope of \text{Def}(.)=0 is the greatest.
real wage. The compensating increase in the REER both boosts output (and hence the required real wage) and makes the actual real wage decline (by increasing prices). In light of the two opposing influences of $e$ on the primary surplus (where it has been assumed that the positive effect on output and tax collection predominates over the negative effect through the conversion to foreign currency of the peso primary surplus) it seems reasonable that a higher increase in $e$ is necessary to increase the Dollar value of the primary surplus than to keep the real wage gap at zero (where the qualitative effect of $e$ is unambiguous).

**Figure 1**

![Figure 1](image)

The long run equilibrium is a saddle-point, as illustrated in Figure 1. Any trajectory that starts from the stable saddle-path (which is shown with arrowheads pointing toward the long run equilibrium point) converges to the long run equilibrium. Any departure from this saddle-path, however, eventually gets arbitrarily close to the line depicted with arrows pointing away from the long run equilibrium, and hence is explosive. The arrows around the two main intersecting lines show the direction of movement of the respective variable when it departs from the locus of points on which it is constant. From

---

$20$ In the case in which the slope of $\text{Gap}(.)=0$ is the greatest the equilibrium point is a focus, and is stable if $\text{Def}_B < \alpha\text{Gap}_e$ (trace $< 0$) and is unstable if $\text{Def}_B > \alpha\text{Gap}_e$ (trace $> 0$). Under the assumption of perfect foresight either of these equilibriums would be problematic (cfr. Begg (1982)). In the Pure Float case below, where it will be seen that the (2 by 2) dynamic system is practically identical to the Convertibility system, an anchor for exchange rate expectations would be lacking.
any initial point that is not on the saddle-path, if e can jump it will and \((B,e)\) will move vertically onto the saddle-path.

The negative signs below the exogenous variables \(\theta\) and \(\rho\) mean that the lines shift to the left whenever the respective exogenous variable increases. Figures 2 and 3 show what happens when e can jump and, starting from a long run equilibrium, the economy is affected by two different exogenous shocks: a devaluation of the Real (an increase in \(\rho\)) and an increase in international risk aversion (\(\theta\)). When \(\rho\) increases (Figure 2), the REER initially jumps onto the new saddle-path and thereafter gradually falls along with B. The jump in the REER boosts output and hence tax collection and the primary surplus. Since the exercise begins with a balanced budget (in the long run equilibrium), the increase in the primary surplus produces a budget surplus that allows for a gradual reduction in the public debt. The increase in the REER also turns the real wage gap positive (by increasing the required real wage and diminishing the actual real wage), so e gradually falls after its initial jump. The new long run equilibrium has a lower debt and a lower REER than initially.

The increase in \(\theta\) is similar (Figure 3), except that this time both lines shift to the left so that, according to how important the relative shifts are, the long run effect on e and B can be diverse. The only combination that can’t occur is an increase in B with a fall in e. If the shift in the Gap=0 line is much smaller than the shift in the Def=0 line, both e and B increase in the long run whereas they both decrease in the polar case in which the shift in the Gap=0 line is much greater than the shift in the Def=0 line. With similar shifts, however, e increases while B decreases in the long run.\(^{21}\)

\(^{21}\) This is the combination which appears to account for what happened with the Argentine economy after the double shock given by the increase in international risk aversion after the Russian crisis and the Brazilian devaluation. The economy needed a lower public debt level and a higher REER to achieve long run equilibrium while exactly the opposite was occurring.
So far, the analysis has assumed that e can jump. But can this be achieved under Convertibility? Take the case of Figure 3, for example, in which there is an increase in risk aversion. With a fixed nominal exchange rate, and $\rho$ constant, according to 7) e can increase only if $P$ falls. Since $P = c W^b \rho^{\lambda(1-b)}$ under a fixed exchange rate ($E=1$ in 11)) and assuming that the mark-up $c$ cannot fall, $P$ can only fall if $W$ does. Hence, the necessary increase in $e$ crucially requires downward flexibility in the nominal wage and in prices. But this is something that one certainly cannot take for granted. Assume, for example, that there are sticky nominal wages so that $W$ can only move smoothly according to (14). Then assuming there is no sudden compression in the margin $(c)$ the domestic price level $P$ cannot jump down either. Hence, under Convertibility the existence of downward nominal wage or price
stickiness implies that there is no way of generating the increase in the REER that can boost output, tax collection and the primary surplus when there is an adverse shock such as an increase in risk aversion.

The case of Figure 2 is slightly more complicated because the devaluation of the Real has the direct effect of lowering \( e \left( = \frac{E}{P \rho} \right) \). If there is price stickiness there is no way \( e \) can jump up to the necessary level. On the other hand, if there is price flexibility there is a fall in \( P \) through the reduction in the cost of imported inputs to production (\( P = cW^b \rho^{\lambda(1-b)} \)). However, because 7) and 11) imply that \( e = 1/[c(W\rho)^b] \), it is readily seen that as long as there is nominal wage stickiness \( e \) necessarily falls when \( \rho \) increases and has no way of jumping upward to the new saddle-path.

**Figure 4**

![Figure 4](image)

What path does the economy follow if \( e \) cannot jump up? Assume that in Figure 4 the economy starts at the initial long run equilibrium (in 1) and there is price stickiness. Since after \( \theta \) and \( \rho \) increase (shifting the long run equilibrium to the upper 2) \( e \) jumps down (to the lower 2) and \( P \) cannot jump down, then \( (B,e) \) can only follow the dynamic path that corresponds to the new saddle-point and starts at the lower 2. As Figure 4 shows, that path slopes upward and to the right because, as seen in Figure 1, \( e \) can only rise in the region below the Gap=0 line and \( B \) con only rise in the region below the Def=0 line. With a fixed nominal exchange rate, as long as \( \rho \) is constant \( e \) can only rise if \( P \) falls, that is, if there is domestic price deflation. And (15) shows that this is the case, because at the lower 2 the rate of nominal depreciation is zero and the real wage gap is negative. Even though the required real wage is lower than the actual real wage, because there is lacking an effective
coordinating mechanism (which a devaluation could produce), the real wage can only decrease gradually as the nominal wage gradually falls more than the consumer price level, delivering a gradual reduction in the domestic price level. On the other hand, the gradual increase in B is due to the fact that the double shock generates a budget deficit that must (and can) be financed by increased indebtedness.

In Figure 4 the shocks are repeated to illustrate that even though deflation in Argentina makes $e$ rise gradually whenever $\rho$ is constant, if its trade partners’ depreciations (other than the U.S.) are recurrent, the actual REER falls. As the economy moves down and to the right to points 2, 3, 4,…, the long run equilibrium moves up and to the left to points 2, 3, 4,…

It is assumed that the public expects that when B reaches a threshold $\bar{B}$ at which there is a sudden stop in foreign financing, the government swaps the Central Bank’s international reserves for all the pesos in circulation and from then on the dollar is used as legal tender. Also, dollar wages and prices suddenly become nominally flexible so that the REER (which is now simply the terms of trade) jumps up to the saddle-path, generating the virtuous circle of increased exports and lower imports, greater output and employment and the budget surplus that makes the public debt fall gradually.\(^{22}\)

10. The Pure Float regime

Under the Pure Float exchange rate regime, the Central Bank determines the paths of M and R and lets the path of C be determined endogenously. The path for R is simply to leave it at its initial level (which is why the float is “pure”). With respect to M, it is assumed that the Central Bank chooses a constant proportional growth path for M, which means that it chooses both the initial level $M_o$ and the constant rate of monetary growth $\mu_o$:

\[
\begin{align*}
F14) & \quad R = R_o \\
F15) & \quad M = M_o e^{t\mu_o}.
\end{align*}
\]

\(^{22}\) If the sudden stop means that not only will there be no new net financing but that there will also be no refinancing of amortizations, then this would put further strain on the required primary surplus and the required jump in $e$. We assume here that this is actually possible, in order to hold on to the perfect foresight framework. But because of the magnitudes involved this was virtually impossible in the Argentine context.
Equation 4) may be expressed as

\[(30) \quad \delta = \frac{1}{l_{-1}}(l_0 - m) \equiv \delta(m), \]

\[\]

giving an expression for the rate of nominal currency depreciation in terms of the stock of base money expressed in Dollars.

Taking the (right-hand side) derivative in 6) and using F15) and (30) gives a third dynamic equation:

\[\]

\[(31) \quad m = m[\mu_o - \delta(m)].\]

Because the only endogenous variable present in this equation is m, its solution gives the law of motion of m. Assuming perfect foresight, and considering that m is a forward looking variable (because the nominal exchange rate E is), the rate of currency depreciation is determined by the expected (and actual) future rate of monetary expansion. Technically, if one discards transitory bubbles, the perfect foresight “saddle-path” in this one dimensional sub-system is the one that keeps m constant at the level that gives a rate of depreciation equal to the exogenous rate of monetary expansion. That is, given the Central Banks choice of M_o and \(\mu_o\), E (and therefore m) jumps to whatever level is necessary to assure that \(\delta(m) = \mu_o\) and thus maintain money market equilibrium. Therefore, as long as the Central Bank does not produce any change in the rate of monetary expansion, 4) implies that m stays at:

\[(32) \quad m_o = l_0 - l_{-1}\mu_o.\]

Any change in the rate of monetary expansion will produce a one time jump in m (through a jump in E) to restore the equality in (32). Also, any change in the level of the money supply M_o produces an equal change in the nominal exchange rate E.

Notice that instead of using (31) one may insert 6) and 8) in 4) to obtain

* \[ \]

\[ E = aE - bM \]

where \(a \equiv l_0/l_{-1}\) and \(b \equiv 1/l_{-1}\). This (linear, non-homogeneous, first-order) differential equation (with M(t) as forcing variable) has the following general forward solution:

\[ E(t) = \int_t^\infty e^{-a(s-t)} bM(s)ds + ce^{at} \]
Where \( c \) is an arbitrary constant. One must choose \( c=0 \) to discard explosive paths ("bubbles")\(^{23}\) and assume continuity for \( E(s) \) for \( s>t \) and right continuity at \( s=t \) to have uniqueness.\(^{24}\) If it is expected that the future path of money will be \( M(s) = M_o e^{\mu_o s} \) (as in F15)), then solving the integral gives:

\[
E(t) = b(a-\mu_o)^{-1}M_o e^{\mu_o t} = \left(l_0 - l_1 \mu_o \right)^{-1}M_o e^{\mu_o t} = E_o e^{\mu_o t}
\]

where \( \mu_o \) must be less than \( a \) for the integral to converge.\(^{25}\) Therefore, the rate of nominal depreciation must be equal to the rate of monetary expansion:

\[
\frac{E}{E} \equiv \delta = \mu_o
\]
as was derived directly from (31). 

Since \( R \) and \( m \) are constant (by F14) and (32)), the first two equations of the system are now:

\[
(F1) \quad e/e = -\alpha \text{Gap}(e, B; \theta)
\]

\[
(F2) \quad B = \text{Def}(e, B; \theta, \rho) - \mu_o m_o
\]

which determine the trajectories of \( e \) and \( B \).

By 5), as long as \( M_o \) and \( \mu_o \) remain constant, \( C/E \) is also constant, but whereas under Convertibility \( C \) and \( E \) were constant (\( C=0, E=1 \)), under a Pure Float regime they both grow at the same rate \( \mu_o \) and may jump if there is a change in monetary policy.\(^{26}\)

Looking at (F1) and (F2), the only apparent difference with the Convertibility system ((C1) and (C2)) is the inflation tax \( (\mu_o m_o) \), which, if it is positive,


\(^{25}\) We will see below that this condition holds if and only if the inflation tax is positive.

\(^{26}\) The paths for the rest of the endogenous variables may be successively determined. For example, (8) and (17) give the path for \( \pi \) as \( \pi = \mu_o + \alpha \text{Gap}(e, B; \theta) \). Then 9) gives the path for \( P \), 7) for \( E \), 10) for \( F \), 11) for \( W \), 12) for \( Q \) and 13) for \( w \), so that the paths for all 14 endogenous variables are determined.
allows the government to finance a larger nominal deficit in the long run. The higher is the inflation tax, the more the \( \text{Def}(.)=\mu_o m_o \) line shifts to the right in Figure 1, and hence the higher are the long run equilibrium values for \( B \) and \( e \).

However, there is a more crucial difference between the Pure Float system and the Convertibility system that has to do with the adjustment mechanism for \( e \). We have seen that if there is downward price or nominal wage stickiness the necessary upward jump in \( e \) after an adverse shock cannot be achieved under Convertibility. The main advantage of a purely Floating regime is that the Central Bank has a more flexible monetary policy that allows this adjustment to take place even when there is price of wage stickiness.

Assume, for example, that in a purely floating regime \( \rho \) has increased and there is price stickiness. By 7), the increase in \( \rho \) has the effect of reducing \( e \). But reaching the new saddle-path requires an increase in \( e \). This can only be achieved by an upward jump in \( E \). If the Central Bank decides to maintain the rate of monetary expansion at \( \mu_o \), then (32) implies that there can be no change in \( m=M/E \). Hence, the only way to achieve the necessary upward jump in \( E \) is to have a proportional one time increase in \( M \). This can be achieved by a one time increase in Central Bank credit to the Treasury (\( C \) in 5)). This monetary injection, and the public’s knowledge that the Central Bank plans to maintain the rate of future monetary expansion at \( \mu_o \), generates a one time increase in the public’s demand for money that accommodates the Central Bank’s monetary injection, leaving \( m \) constant.27

Alternatively, if the increase in \( \rho \) is not too big, the Central Bank could completely offset its effects through an increase in the rate of monetary expansion \( \mu \) and thus avoid the need for any jump in \( e \) whatsoever. (32) implies that in general the inflation tax \( \phi \equiv \mu m \) is equal to

\[
\phi (\mu) = \mu (l_0 - l_1 \mu).
\]

This function is initially increasing, has a maximum at \( (1/2)(l_0/l_1) \) equal to \( (1/4)(l_0^2/l_1) \) and decreases thereafter. Hence, if the initial rate of monetary expansion is sufficiently below the rate that collects the maximum inflation tax, by increasing it the Central Bank can shift the \( \text{Def}(.)=\phi (\mu) \) locus back to where it was before the change in \( \rho \). The increase in \( \mu \) has the effect of

27 The reader may notice that this paper does not address the important issue of credibility.
reducing \( m \) discretely through an upward jump in \( E \). And this upward jump in \( E \) completely compensates the downward jump in \( e \) produced by the initial increase in \( \rho \), keeping the output gap (and unemployment) at its long run level. The increase in \( E \) is achieved through the pressure that the portfolio shift towards Dollar assets produces in the foreign exchange market as a consequence of the higher rate of depreciation of the Peso.

In Figure 5, the effect of the increase in \( \rho \) on the steepest line in the right-hand quadrant is completely compensated by the effect of the increase in \( \mu \), so that the intersection of the two lines stays at 1. The figure includes a quadrant on the left hand side to illustrate the monetary developments, showing a family of hyperbolas that correspond to the identity \( me = M/(P\rho^\lambda) \). The increase in \( \rho \) shifts the initial hyperbola to the right and the increase in \( \mu \) reduces \( m \) from \( m_0 \) to \( m_1 \).

Of course, under a Pure Float the Central Bank has the ability to produce any combination of changes in \( M \) and \( \mu \) that lead to the needed instantaneous adjustment in \( E \). Assuming now that the exogenous change was in \( \theta \), given a certain \( de \) that has to be obtained to reach the new saddle-path, (7) implies that (if \( P \) cannot jump) the needed change in \( E \) is

\[
(33) \quad dE = P\rho^\lambda \, de.
\]

Then (6) and (32) imply that

\[
(34) \quad dE/E = dM/M + \left( \frac{l_1}{m} \right) d\mu,
\]
which gives the different combinations of $dM$ and $d\mu$ that produce the required $dE$, and hence the required $de$ (by (33)). One interesting implication is that the required increase in the nominal exchange rate can be obtained with a reduction in the rate of monetary expansion ($d\mu < 0$), and hence a reduction in the rate of depreciation and in the long run domestic inflation rate, as long as there is a one time monetary expansion that is sufficiently larger percentage-wise than the required change in the nominal exchange rate ($dM/M > dE/E$). In Figure 6, the new long run equilibrium is in 3, in which the two thick lines already incorporate the increases in $\theta$ and $\mu$. The impact of $d\theta$, $dM$ and $d\mu$ is to move e and m to 2 (in the respective quadrants). The slow dynamics thereafter gradually leads to 3.

[Assume that under a Convertibility regime, at some point the government announces that if and when the threshold is reached the Central Bank will stop intervening in the foreign exchange market and start financing the Treasury by issuing money at an exogenous rate. Since this would imply an opportunity for capital gains on holdings of dollars, by the usual backward induction argument there would be an immediate run on the currency as soon as the announcement is made. The nominal exchange rate jumps up and the economy reaches the saddle-path. In this case there is no need to assume any (miraculous) change in the behavior that generates nominal price or wage rigidity. This model is formally equivalent to one in which there is a sudden and unexpected change in the regime, so that the Central Banks stops intervening and adopts a Pure Float. The next section looks at this version of the model.] VER

The possibility of achieving a jump in $E$ and a subsequent positive rate of inflation (as is the case under a Floating exchange rate regime) is certainly a plus in an economy where downward price or nominal wage rigidity prevails. Quick adjustments to any succession of adverse capital market and foreign exchange market shocks can take place and therefore imbalances do not build up as they can under the Convertibility regime.

**A timely exit from Convertibility**

The Convertibility regime was successful in Argentina for anchoring inflationary expectations after the extreme instability that generated two

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28 The economics underlying this motion will be spelled out in the next section.
hyperinflationary episodes. Instead of getting stuck in the “hard peg” corner that was proclaimed to be sustainable by many sympathizers of the “bipolar view” (according to which the middle ground between hard pegs and free floats was “hollowing out”), Argentina could have successfully exited the Convertibility regime if its policymakers had understood the extreme vulnerability that this regime implied to certain “states of nature”.

This section briefly illustrates a version of the model in which there is a successful regime switch from Convertibility to a Free Float within the general macro model developed in the previous sections. Assume that there is price stickiness and that after the economy accumulates some real currency appreciation the regime is (unexpectedly) abandoned for a Free Float with a credibly announced rate of monetary expansion $\mu_o$. Starting at 1 in Figure 6, the nominal exchange rate jumps up to the level compatible with the new saddle-path at the existing debt level (at 2).

When $E$ jumps from 1 to its new level, since $P$ cannot jump (and assuming the Central Bank does not produce an instantaneous change in $M$), then $m$ and $e$ jump along the initial hyperbola from 1 to 2. The real depreciation boosts the economy, and hence tax collection, making the government have a budget surplus, so that it can gradually reduce its debt level.

![Figure 6](image)

In the initial situation there was deflation, since in (15) $\delta$ was zero and the real wage gap was negative (the required real wage was lower than the actual real wage). After the floating of the exchange rate, the rate of nominal depreciation instantaneously jumps to $\mu_o$. Furthermore, the real wage gap becomes positive.
because the real wage falls (because it varies inversely with the REER) and the required real wage jumps up (because the output gap becomes less negative or positive). As a result, domestic inflation suddenly becomes positive and greater than the rate of depreciation, so that $e$ declines gradually towards its new long run equilibrium level. After the initial increase, the domestic inflation rate gradually decreases towards the rate of monetary expansion as the real wage gap decreases to zero. In the left quadrant of Figure 6, since the rate of monetary expansion stays constant at $\mu_o$ after the initial increase and so does the rate of nominal currency depreciation, there is no further change in $m$. However, the gradual increase in $P$ gradually shifts the hyperbola down and to the right, while $e$ falls gradually.

V. Conclusions

The Convertibility experience in Argentina confirms the view that fixed exchange rates do not have a natural tendency to induce prudent fiscal policies as long as there are liquid capital markets to finance deficits, and even if the regime is long lasting. It also confirms that the low inflation gains may be temporary and followed by a return to high inflation if the regime collapses. Although it is clear that this would not be true if there were sufficient price and wage flexibility, this conditional statement appears to be void of empirical content. Argentina’s experience once more confirms that in actual situations there is often insufficient downward nominal flexibility to avoid the build-up of large real exchange rate misalignments. The harder the peg, the more the fixed exchange rate regime may last and the greater is the build-up of macroeconomic imbalances. Convertibility was a very hard peg, not only because the currency board arrangement implied full backing of Central Bank liabilities with international reserves but also because of the anti-inflation bias that pervaded Argentine society after the hyperinflationary experience, the “Russian roulette” strategy of completely disregarding currency mismatches in the non-financial sectors so that a devaluation would wreck the financial system, and the international support the regime had, even when the explosive nature of the dynamics of the public debt, the REER and unemployment was evident.

This paper has briefly reviewed Argentina’s experience with convertibility and has illustrated the dynamics of Convertibility through different versions of
a general macroeconomic model where the economy is hit by large and persistent adverse shocks such as increases in risk aversion and real depreciations of non-Dollar currencies. Under Convertibility, if there is downward nominal price or wage rigidity the economy follows an explosive REER, public debt and unemployment path when the adverse shocks are larger or faster than the gradual REER correction that price and wage deflation can achieve. In some of the versions of the model, if everyone expects that when the public debt reaches an exogenous threshold there will be Full Dollarization and a simultaneous reduction in Dollar prices and wages (say because there is a previous devaluation but with a pre-devaluation swap of Pesos for Dollars) the economy jumps onto the saddle-path. In this case, however, the story can start all over again if there are new shocks.

Under a (fully credible) Pure Float the system would be able to cope with nominal rigidities at all times by virtue of the adjustments achieved through jumps in the nominal exchange rate whenever the economy receives adverse shocks. If under Convertibility it were unexpectedly announced that a Pure Float regime would be adopted when the public debt threshold is reached, the Pure Float would immediately ensue by virtue of an attack on the currency by which the public purchases all the Central Bank’s reserves.

The author’s view is that myopic behavior characterized most agents of the economy during the Convertibility experience, so that an explosive interpretation of the model is a better description of events than any perfect foresight version of the model. Of course, it is impossible to contain within a perfect foresight model the uncertainty that pervaded economic agents under Convertibility as to what the government would actually do if worse came to worse, i.e., if there were a sudden stop in foreign financing or if there were a massive run on the currency.

[Future research will have to surpass the simple perfect foresight modeling in order to represent the Argentine experience (and dilemma) in a theoretically more satisfactory way.] VER

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