POLITICAL ECONOMY RESEARCH INSTITUTE

PERI

University of Massachusetts Amherst

POLITICAL ECONOMY
RESEARCH INSTITUTE

Exchange Market Pressure, Monetary Policy, and Economic Growth: Argentina in 1993 - 2004

Clara Garcia
Nuria Malet

2005

UMASS

WORKINGPAPER SERIES

Number 99

EXCHANGE MARKET PRESSURE, MONETARY POLICY, AND ECONOMIC GROWTH: ARGENTINA IN 1993-2004

Clara García

Department of General Economics and Statistics, University of Huelva (Spain)

(written during a research stay at Political Economy Research Institute,

University of Massachusetts-Amherst)

Nuria Malet

Department of Economics, University of Massachusetts-Amherst

The pressure in the exchange market against a particular currency has been frequently measured as the sum of the loss of international reserves plus the loss of nominal value of that currency. This paper follows the tradition of investigating the interactions between such measure of exchange market pressure (EMP) and monetary policy; but it also questions the usual omission of output growth in the empirical investigations of the interrelations between EMP, domestic credit, and interest rates. The focus of this work is Argentina between 1993 and 2004. As in previous studies, we found some evidence of a positive and double-direction relationship between EMP and domestic credit. But output growth also played a role in the determination of EMP, even more than domestic credit or interest rates. Also, there is some evidence that EMP affected growth negatively.

1. Introduction

The 1990s and the first years of the 21st century have been marked by the occurrence of financial crises in emerging economies, Argentina being so far the last of the series. Currency collapses are, by definition, the result of an excessive pressure in the exchange markets, the determinants of which – as well as its consequences in terms of monetary policy – have been a matter of study for several decades now. Since the currency market imbalance that the exchange market pressure (EMP) gauges is unobservable in a direct manner, EMP has been traditionally measured according to the adjustments that are necessary to correct such imbalance. Maybe the most known amongst those measures is the one proposed by Girton and Roper (1977) (G-R hereafter). These authors calculate EMP as "the volume of intervention necessary to achieve any desired exchange rate target" (ibid., p. 537); such intervention being understood as either currency market operations or adjustments in the exchange rate (or both). Thus, EMP is measured as the loss of nominal value of the domestic currency (adjustment via price) plus the loss of foreign exchange reserves of the domestic monetary authority[1] (adjustment via quantity).

G-R derive this particular measure of EMP from a monetary model – a model of the supply and demand for domestic currency. As we shall see, this model suggests that there is a relationship, not only between monetary policy and EMP, but also between output growth and EMP. In spite of the presence of growth in the monetary model – and despite the fact that some second-generation models of currency crises had highlighted the influence of weak economic growth on the probability of suffering a financial crisis – the empirical studies about EMP performed in the 1990s and beyond, and which use VAR techniques, tend to omit the output growth variable. The obvious downside of such omission is the risk of bias[2] in the results regarding the relations between monetary policy

---

[1] As we shall see, this loss of foreign exchange reserves is scaled by base money, as derived from a monetary model of equilibrium in the exchange market.

[2] One of the requirements for unbiased estimators is that either there is no omitted variables or the omitted variables are not correlated with the regressors included. Since GDP growth is obviously correlated to domestic credit and interest rates, omitting it will introduce bias in the parameters estimated for the other two.

and EMP; and, in general, an excessive simplification of the events surrounding a financial crisis.

The focus of this work is Argentina between 1993 and 2004. To the best of our knowledge there has been no study of the interactions between EMP, monetary policy, and output growth for Argentina in the time before and around the collapse of the convertibility plan. Also, we have not encountered analysis of EMP (in Argentina or elsewhere) utilizing VAR techniques that include output growth.

Our results can be summarized in the following manner. First, like other, previous studies, we found some evidence of a positive and double-direction relationship between EMP and domestic credit. Second, we found that output growth also played a role in the determination of EMP, as theoretical models suggest and as empirical works prior to the 1990s had already indicated. Furthermore, there is some evidence that EMP affected growth negatively. Third, higher interest rates did not result in lower EMP, via higher capital inflows, as certain open-macroeconomic models suggest, but in higher EMP, probably reflecting devaluation expectations. Fourth, we found mixed results on whether monetary policy was pro- or counter-cyclical. In any case, it appears that resorting to higher domestic credit growth in the face of sluggish output growth was counterproductive, suggesting that the latter depended on externally- rather than internally-generated liquidity. Finally, our results confirm the difficulty, under a currency board, of sterilizing the loss (gain) of international reserves with an expansion (restriction) of monetary policy.

As we will show, these results are consistent with both a properly specified monetary model and with certain second generation models of currency crises.

The remainder of the paper is organized as follows. In section 2 we present a review of the literature on the concept and measurement of EMP; the empirical studies about the determinants of EMP; and currency crisis models. In section 3 we develop a theoretical model of the determination of EMP, similar to that in G-R; and we discuss other possible theoretical links between the variables that appear in the model, including those presented in models of currency crises. In section 4 we specify an empirical model for Argentina,

which we estimate using a VAR technique; and we present our main results. In section 5, we offer some final remarks.

2. Literature Review

Many studies have developed monetary models similar to the one found in G-R, and have looked into the determinants of EMP using econometric tests. Some of these analyses estimate their models with Ordinary Least Squares (OLS), as is the case with Girton and Roper themselves, who analyze the determinants of EMP in Canada during 1952-1974, as well as the independence of Canadian monetary policy. Connolly and da Silveira (1979) also use OLS in order to explain EMP in Brazil during 1955-1975. Unlike later studies which use different estimation procedures, these two studies do not exclude output growth – one of the variables that appear in the monetary model – from their empirical specifications. Furthermore, in both cases, output growth is statistically significant and exhibits the expected inverse relationship with EMP.

More current works prefer to apply a VAR technique in order to account for the many possible interactions between the variables in monetary models. Tanner (2001), in particular, uses a VAR technique to unravel the interrelations between EMP and monetary policy (observable in changes in domestic credit and the interest rate differential) for the cases of Brazil, Chile, Mexico, Indonesia, Korea, and Thailand in 1990-98. He concludes that a contractionary monetary policy eases EMP, in spite of which an increase in EMP translates into higher credit growth in most cases. Another study of EMP with VAR can be found in Kamaly and Erbil (2000), who present a very similar study applied to Turkey, Egypt, and Tunisia. Their results are somewhat more mixed than Tanner's. Finally, Gochoco-Bautista and Bautista (2002) investigate the relationships between monetary policy and EMP in the case of the Philippines, and test for the existence of different results before and after the currency crises of 1997-98. They conclude that the responses of monetary policy to EMP were more contractionary in the crisis period; also, that the impact of interest rates on EMP was negative in the tranquil period, but positive in the crisis period.

Girton-Roper's intuition that the currency market imbalance can be observed in policy measures has been adopted to develop other, model-independent measures of EMP. Eicheingreen *et al*. (1994 and 1995) choose to make the definition of EMP independent of a monetary model, and add the change of interest rates to G-R's EMP; according to these authors, rising interest rates is another way of fighting an excess demand for foreign currency. Also, again departing from the monetary model, they assign weights to the different components of EMP so that they have the same conditional variance (as was also done by Kaminsky *et al*., 1997).

Currency crises have been sometimes identified as an unusually large EMP (i.e. an unusually large gap between supply and demand for a particular currency), as in Eicheingreen *et al*. (1994 and 1995) and Kaminsky *et al*. (1997). Given this close relationship between EMP and currency distress, and given that our aim is to study the case of Argentina around the currency collapse of 2002, it is worth reviewing briefly the literature about currency crises (for a critical review and explanation of currency crises models, see Bustelo *et al*., 2000).

First generation models appeared with an article by Krugman (1979), where currency crises are the consequence of financing public deficits with an expansionary monetary policy under a fixed exchange rate. In other words, currency collapses are the result of the incompatibility of fiscal and monetary policies with a fixed currency. Extensions of Krugman's model include Flood and Garber (1984) and Connolly and Taylor (1984). Dooley (1997) presents a very different first generation model where the policy inconsistency arises from a different set of government actions: the maintenance of international reserves as an insurance against shocks, and the provision of institutional guarantees. In this model, a banking crisis precedes the currency crisis. In sum, and generally speaking, first generation models explain currency crises as inevitable and predictable phenomena that arise because of policy inconsistencies.

Second generation models appeared in the mid-1980s, but became more prominent after the financial crises of the European Monetary System (EMS) (1992-93) and Mexico (1994-95). In second generation models the abandonment of a fixed exchange rate is not the inevitable outcome of an exclusively economic process, but a political choice that depends

on the costs and benefits of the maintenance of a peg. Also, these models posit that the costs of maintaining a peg depend in part on devaluation expectations: when private agents expect a devaluation, the policy measures required to maintain the peg make such maintenance more costly. Hence, devaluation expectations become self-fulfilling. It is important to remember that the phenomenon of self-fulfillment does not imply that fundamentals play no role in the generation of crises (see Obstfeld, 1996; Cole and Kehoe, 1996 and 1998; and Chang and Velasco, 1998). Therefore, the distinction between first and second generation models according to whether fundamentals play a role in causing crises is a simplistic one.

In some models, public debt, as well as its maturity and currency structure, poses costs for the maintenance of the peg; and these costs may be enhanced by speculative pressures (Obstfeld, 1994 and 1996; Cole and Kehoe, 1996 and 1998). Other models show that real sector problems (sluggish growth, unemployment, or loss of external competitiveness) can also make the peg costly and are worsened in the presence of devaluation expectations (Obstfeld, 1994; Ozkan and Sutherland, 1995). Finally, in third generation models – which are sometimes considered a financial version of second generation models – maturity and currency mismatches in the financial sector open the door to self-fulfilling expectations of default. Given the existence of institutional guarantees (implicit or explicit, real or perceived), the banking crisis is followed by a currency crisis (Calvo, 2000; Chang and Velasco, 1998).

In sum, and generally speaking, in second (and third) generation models currency crises are contingent – and therefore non-predictable – events, which occur as the consequence of the self-fulfillment of devaluation (and/or default) expectations in a context of less-than-healthy fundamentals. Second generation models in which the cost of maintaining a peg arises from weak economic growth are most pertinent to our discussion, given that they can be linked to G-R's monetary model, where EMP shows an inverse relationship with growth.

We now turn to the particular case of Argentina. In this paper we do not address directly the collapse of the currency regime in January 2002. In other words, we do not attempt to explain the exact timing of the success of the pressures against the nominal value of the

currency, but rather the pressures themselves, as well as the interrelations between these and certain financial and non-financial variables. The closeness of EMP and the currency collapse is, nevertheless, evident. [3]

Many explanations have been posed for the banking and currency crisis that Argentina suffered. Some authors (Mussa, 2002) have stressed the policy inconsistency between a fixed exchange rate and the fiscal deficits that rendered public debt growth – a reasoning very similar to that found in first generation models of crises. This perspective has been widely criticized (see Haussman and Velasco, 2002; and Bustelo, 2004).

More popular accounts of the crisis tend to focus on trade- and growth-related problems. In particular, it is said that the fixed exchange rate, together with external shocks (and maybe even capital inflows), led to a real misalignment of the Argentinean peso. This overvaluation, in turn, led to the contraction of production (de la Torre *et al.*, 2003). In fact, Kaminsky (2003) classifies the 2002 Argentinean crisis as a "current account" crisis, which refers, in her taxonomy, to crises that stem mostly from the real appreciation of the domestic currency.

Other authors, when explaining Argentina's crisis, concentrate on financial fragilities: those of the public sector, whose debt was increasingly difficult to service, but also those of the private sector, which suffered increasing credit, exchange-rate and liquidity risks (de la Torre *et al.*, 2003; Bustelo, 2004).

In any case, most interpretations consider that combinations of all the aforementioned explanations provoked the crisis. Perry and Servén (2003) indicate that Argentina was vulnerable to external shocks due to the interactions between a fragile fiscal position, a real overvaluation (and the consequent deflationary adjustment), and financial problems (mismatches in the portfolios of banks' borrowers, public debt, etc.). De la Torre *et al.* (2003) posit that the main problems – which reinforced one another – were weak growth,

---

[3] Not only it is evident theoretically speaking, but also in the particular case of Argentina. A graph of Argentina's EMP (not reported) shows that the second highest point in EMP coincided with the abandonment of the currency board, and that the highest point came soon thereafter.

public debt, and a real misalignment of the peso: "The elements of the CGD [currency-growth-debt] trap reinforced each other in a perverse way. Continued economic contraction, increasing doubts about the sustainability of the public debt, and soaring uncertainty about the permanence of the one-peso-one-dollar rule fell into a vicious circle" (ibid.: 11).

Finally, there is some formal empirical evidence about the role of fundamentals and expectations in the Argentinean crisis. Most interesting for our work are the results in Álvarez Plata and Schrooten (2003a), who apply to the Argentinean case the early warning signals approach developed by Kaminsky *et al*. (1997). In that approach, a measure of EMP similar to ours is utilized to identify currency crises.[4] These authors conclude that, two years prior to the January 2002 collapse, the only indicator sending a warning signal was the output variable. Using a Markov regime-switching method, Álvarez Plata and Schrooten (2003b) conclude that the Argentinean crisis had elements of self-fulfillment, in view that it happened after several months of high devaluation expectations.

To conclude, most empirical studies point to the fact that, unlike other crises (i.e. the East Asian crises), where the recession is most acute after the financial collapse, the Argentinean currency crisis was preceded by many months of weak economic growth.

3. Theoretical Framework

3.1. The Formal Model

As mentioned above, a common model-dependent measure of exchange market pressure was presented by Girton and Roper (1977). According to G-R, EMP can be derived from a model of equilibrium in the money market. Following their work, we also extract our measure of EMP from a monetary model with an exponential specification of the demand for base money. The equilibrium condition for a given country can be written as:

---

[4] Currency crises are said to happen when the exchange market pressure is at least its mean plus two standard deviations.

$$H = F + D = PY^{\beta} \exp(-\alpha\rho) \tag{1}$$

where: H = supply of base money issued by the central bank
  F = base money backed by foreign reserves
  D = base money created by domestic credit expansion
  P = price level
  Y = real income
  ρ = index of interest rates
  β = income elasticity
  α = interest rate coefficient

Taking the logarithmic derivative of the above expression, we obtain the equilibrium condition expressed in growth rates:

$$\ln H = \ln(F + D) = \ln P + \beta \ln Y - \alpha\rho \tag{2}$$

and

$$\frac{1}{H}\frac{dH}{dt} = \frac{1}{H}\frac{d(F+D)}{dt} = \frac{1}{P}\frac{dP}{dt} + \beta\frac{1}{Y}\frac{dY}{dt} - \alpha\frac{d\rho}{dt} \tag{3}$$

The base money created against foreign reserves can be expressed as:

$$F(t) = \int_{-\infty}^{t} E(t)R'(t)dt \tag{4}$$

where: $R(t)$ = stock of international reserves held by the authorities
  $R'(t)$ = net purchases of international reserves at time t by the authorities
  $E(t)$ = parity of the primary reserve assets at time t

Taking the first derivative of (4) and replacing in (3) we obtain:

$$\frac{1}{H}\frac{dH}{dt} = \frac{1}{H}\left[\frac{EdR}{dt} + \frac{dD}{dt}\right] = \frac{1}{P}\frac{dP}{dt} + \beta\frac{1}{Y}\frac{dY}{dt} - \alpha\frac{d\rho}{dt} \tag{5}$$

Now, we can define: $h = \frac{1}{H}\frac{dH}{dt}$ $r = \frac{E}{H}\frac{dR}{dt}$ $d = \frac{1}{H}\frac{dD}{dt}$

$\pi = \frac{1}{P}\frac{dP}{dt}$ $y = \frac{1}{Y}\frac{dY}{dt}$ $\rho' = \frac{d\rho}{dt}$

Hence, the equilibrium equation for a given country can be written as:

$$h = r + d = \pi + \beta \, y - \alpha \, \rho' \qquad (6)$$

To analyze the interaction between Argentina's peso and the US dollar, we subtract the equilibrium condition of the US from that of Argentina. The fact that Argentina and the US have an asymmetric relationship will be taken into account later in the development of the model.

Let the subscript "a" indicate Argentina and the subscript "u" indicate the US. Hence, we can write

$$h_a - h_u = (r_a + d_a) - (r_u + d_u) = (\pi_a + \beta_a \, y_a - \alpha_a \, \rho'_a) - (\pi_u + \beta_u \, y_u - \alpha_u \, \rho'_u) \qquad (7)$$

Contrary to Girton and Roper, we will not assume equal interest rate coefficients in both countries. Then, defining $\theta_{au} = \pi_a - \pi_u + \dot{e}$ as the differential inflation rate adjusted for exchange rate changes $\left(\dot{e} = \frac{1}{e} \frac{de}{dt} \right)$[5], regrouping the terms in (7), and replacing, we obtain:

$$r_a - r_u + \dot{e} = -d_a + d_u + \beta_a \, y_a - \beta_u \, y_u + \theta_{au} - \alpha_a \rho'_a + \alpha_u \rho'_u \qquad (8)$$

The expression on the left hand side of the equation is a measure of the exchange market pressure in both Argentina and the US, as observed in the changes of the nominal exchange rate and of foreign reserves (these being the two alternatives that this model offers to authorities in order to re-establish equilibrium in the currency market).

Again following G-R, we take into account the extreme asymmetry between the two countries, which implies that the smaller economy – in our case, Argentina – will bear all the burden of exchange rate adjustment in the face of a gap between supply and demand

---

[5] In this work, the exchange rate (*e*) is defined as number of units of foreign currency per unit of domestic currency. Therefore, a decrease in *e* represents either a depreciation or a devaluation.

for pesos against dollars. This justifies transferring the US balance of payment imbalances (r_u) to the right hand side of the equation. Added to d_u, it yields h_u. Finally, we multiply the entire equation by negative one, which results in:

$$EMP \equiv -(r_a + \dot{e}) = d_a + \alpha_a \rho'_a - \beta_a\, y_a - \theta_{au} + \beta_u\, y_u - h_u - \alpha_u \rho'_u \qquad (9)$$

We have chosen to change the sign of the entire equation in order to obtain a measure of exchange market pressure. As mentioned previously, EMP is supposed to gauge the excess supply of pesos against dollars in currency markets, observable in a *loss* of reserves and/or a *fall* in the nominal value of the currency. If the left side of the equation was positive, EMP would have moved inversely against it, making the analysis somewhat counterintuitive.

3.2. Theoretical Implications

There is a growing literature that uses versions of this model to investigate the relationship between monetary policy and EMP. As reviewed in the survey, many recent analyses conclude that monetary contraction reduces the exchange market pressure (Tanner, 2001; Kamaly and Erbil, 2000). Such works concentrate on the relationships between monetary policy and EMP, to the extreme of discarding from their empirical specifications the non-financial variables of the monetary model, namely the output variables. In particular, Tanner (2001) simply assumes that the change in the demand for money is zero, therefore implicitly assuming that its determinants (such as GDP) will not affect EMP. Kamaly and Erbil (2000), meanwhile, do not resort to a theoretical assumption about the effects of growth on EMP, and simply eliminate it from empirical testing due to data availability problems.

We consider that to disregard economic growth as a significant part of the model, and consequently to omit it in an empirical specification, implies an overly simplistic understanding of the monetary model; testing this model without controlling for growth may yield results that are not reliable. The inverse relationship that the model shows between output growth and EMP can be intuitively justified by virtue of the model itself: lower growth implies a smaller increase of money demand, which requires an adjustment

via either a loss of reserves or a fall in the nominal exchange rate. Other theoretical arguments also make difficult the exclusion of growth from a study of EMP. For instance, some of the aforementioned second generation models of currency crises state that lower growth may feed devaluation expectations, therefore bringing about pressures on the domestic currency.

As Kamaly and Erbil (2000) indicate, the apparent simplicity of the monetary model hides the many possible interactions between variables. The interest rate, for instance, deserves further consideration. In addition to the direct effect of an increase of domestic interest rates on EMP, related in the model to a lower demand for money, there may also be an indirect effect, as described in the literature about monetary transmission. When money and bonds are seen as imperfect substitutes, higher interest rates reduce commercial banks' reserves and bonds; therefore, the household sector must hold less money and more bonds. If prices are sluggish, this implies that the household sector will be holding less than the desired amount of money in real terms, which will induce an increase in real market interest rates. In turn, such an increase will affect investment and consumption in durable goods, which will have a negative impact on economic activity. When the possibility of a transmission mechanism is taken into account, the relationship between interest rates and EMP is reinforced. According to the monetary model *and* the monetary transmission mechanism, an increase in the interest rate in the country under study would induce an increase in the exchange market pressure, both directly – as indicated by equation (9) – and indirectly, via a decrease in output.

However, it has been frequently argued that the relationship between interest rates and exchange market pressure is *precisely opposite* to that portrayed in the monetary model. Tanner (2001) and Kamaly and Erbil (2000) hypothesize that monetary restriction is good for the value of the currency, regardless of whether it is implemented via domestic credit contraction or interest rate increases; and they do so in spite of having derived their empirical study from monetary models similar to the one just presented. The recommendations of the International Monetary Fund (IMF) in the midst of, for instance, the East Asian financial crises, also suggest the belief in a negative relationship between interest rates and EMP. The rationale behind such consideration is that, under capital

mobility, a higher (lower) interest rate differential attracts (expels) foreign investment, which, in turn, shrinks (widens) the gap between domestic currency demand and supply (i.e. implies a decrease (increase) of EMP).

We now turn to a further discussion of the domestic credit variable. The argument of the monetary transmission mechanism may similarly apply to domestic credit. Credit rationing might induce a cutback in the supply of loans by the commercial banks – due to their lack of reserves – especially affecting those firms that rely mostly on bank loans for their investment activities. When the possibility of a transmission mechanism is considered, the relationship between domestic credit and EMP becomes ambiguous. On the one hand, the monetary model indicates that a restrictive credit policy will decrease market pressure against the domestic currency. On the other hand, if a decline in domestic credit growth brings about a slowdown of growth, this may in turn provoke an increase in EMP.

In any case, taking into account both the monetary model and the possible indirect effects of monetary policy on EMP, the GDP variable appears to be too relevant to be ignored. Furthermore, there is some empirical evidence of its importance, as was mentioned earlier in this paper. See above how the empirical studies of Girton and Roper (1977), Connolly and da Silveira (1979), and Alvarez Plata and Schrooten (2003) all concluded that output growth played a role in the determination of EMP. Furthermore, Eichengreen *et al.* (1995) argue that successful speculative attacks[6] on the currency – that is, attacks that result in devaluation – are usually preceded by lower GDP growth (as opposed to unsuccessful ones). In sum, there is no theoretical or empirical justification for omitting GDP from an empirical specification of the monetary model[7].

---

[6] Speculative attacks are identified as unusually high values of exchange market pressure.
[7] The validity of monetary models, such as the one here developed, has been questioned largely due to these models' inability to forecast exchange rates. Nevertheless our interest is not to develop a better monetary model, or to forecast the Argentinean exchange rate, but to attempt a more comprehensive empirical use of that simple model. Furthermore, we are not as concerned with the determination of the exchange rate – constant in Argentina for most of the period studied – as we are with a more general measure of EMP, determined mostly by reserve losses in the case under study. Hence, the fact that monetary models do not work for explaining exchange rates need not represent a problem.

3.3. EMP and Currency Crises

Finally, a brief note on the links between the monetary model and models of currency crises. As indicated above, currency crises have been on some occasions defined as a function of EMP. For example, Kaminsky *et al.* (1997) define crises as those periods when an exchange market pressure index (slightly different from our own) exceeds its mean plus three standard deviations. Eichengreen *et al.* (1995) consider that an exchange market crisis occurs when their index of speculative pressure (again, similar to our EMP) rises above the mean plus two standard deviations.[8] Hence it is no surprise that our theoretical model bears some relationship with currency crisis models. That is, aspects of both first and second generations of crises are portrayed in the monetary model; therefore, both could be partially and indirectly tested by testing the monetary model.

On the one hand, first generation models consider that an expansionary monetary policy (via an increase in domestic credit not matched by an increase in money demand) will end up with the loss of international reserves, as long as there is a fixed exchange rate. Hence, if an empirical result indicates that domestic credit does in fact increase EMP – maybe because of scarce monetary transmission to economic activity – the idea in Krugman (1979) can be somewhat supported.

On the other hand, second generation models state a circular relationship between devaluation expectations, interest rate differentials, and any fundamentals-related problem that makes costly the maintenance of the nominal peg. Our monetary model includes all the elements in that circular relationship: interest rates; economic growth, which is among those variables whose deterioration makes it costly to maintain a peg; and EMP, which reflects, *inter alia*, devaluation expectations, since these would materialize in an excess supply of domestic currency. Like the monetary model, together with monetary transmission mechanisms, second generation models predict a direct relationship between

---

[8] If we consider that crises are periods when EMP is above the its mean plus two standard deviations, and using our measure of EMP (details on calculations below), Argentina suffered a currency crisis in March 2001 – which did not succeed in forcing the abandonment of the peg – and from January to May 2002, with the peg abandoned within the first month.

domestic interest rates and EMP, an inverse relationship between interest rates and GDP growth, and an inverse relationship between growth and EMP.

4. An Empirical Application to Argentina

4.1. Specification of an Empirical Model

As we have already suggested, our interest is to test the interactions between not only EMP and monetary policy, but between EMP, monetary policy, *and* economic growth. We understand, as other studies do, that interest rates are the product of both monetary policy and market forces. We chose to investigate the particular case of Argentina from January 1993 to March 2004 – that is, during much of the convertibility plan and several months after its collapse. The time span was selected according to data availability for the relevant series.[9] Argentina seems a suitable subject for this study given the existence of a good monthly proxy for its GDP – and given, of course, the magnitude and impact of its recent crisis.

As observable in the many theoretical links between the variables under study, an analysis of the determinants of EMP using OLS would suffer from endogeneity problems. For that reason, we follow previous studies and use a VAR technique. All US variables (y_u, h_u, and ρ'_u) will be considered exogenous to the VAR, and so will the deviation from the PPP rule (θ_{au}), given that they are all determined outside the Argentinean system and that Argentina, as a "small" country, cannot influence them. The other four variables (*EMP*, d_a, ρ'_a, y_a) will be endogenous to the VAR.

Therefore, the empirical model to be estimated can be written as

$$Y_t = \sum_{j=1}^{p} A_j Y_{t-j} + INFDIF_t + GRUS_t + MBUS_t + INTUS_t + u_t \qquad (10)$$

---

[9] Argentina changed its National Accounting System in 1993 and INDEC (Institute for Statistics and Census) had not provided an official matching for many of the required series at the time of the study.

where
$$Y_t = \begin{bmatrix} EMP_t & DCAR_t & GRAR_t & INTAR_t \end{bmatrix}$$
$$\{u_t\} \equiv \text{is the error term matrix with mean 0 and var - cov matrix } \Sigma_u$$

and   *EMP*: exchange market pressure (Argentina)

DCAR: domestic credit change scaled by lagged base money (Argentina)

GRAR: output growth rate (Argentina)

INTAR: change in an index of interest rates (Argentina)

INFDIF: purchasing power rule deviation (Argentina vs. United States)

GRUS: output growth rate (United States)

MBUS: monetary base growth rate (United States)

INTUS: change in an index of interest rates (United States)

As mentioned above, Kamaly and Erbil (2000) exclude growth from their empirical specification due to the unavailability of monthly GDP data. We have already seen how most works agree on the relevance of the recession prior to the final collapse of the Argentinean currency. To avoid omitting output growth from our specification we used INDEC's monthly Estimator of Economic Activity as a proxy for GDP. For the US, and to the best of our knowledge, an equivalent estimator is not produced, compelling us to linearly interpolate the quarterly series in order to obtain monthly data.

To produce the indexes of interest rates, and with the aim of capturing both policy and market-related rates, we used principal components that explained up to 99% of the variability of all interest rates used in the calculation. In the cases of both Argentina and the US, the principal components were computed using all the available short-term interest rates for which data was sufficient in the period under study (see Appendix for further details). The covariance matrix was used to calculate the principal components.

All the series were built as defined in the theoretical model. All data was obtained from the International Financial Statistics cd-ROM (IFS), published by the IMF, and from

INDEC's and BCRA's[10] web pages. For a full description of the methodology and sources, see the appendix.

All series but *GRAR* tested negative for unit roots, at a 99% level of significance or more, according to two Phillips-Perron tests – with intercept only and with intercept and trend. *GRAR* passed the first test at a 90% level of significance but did not pass the second test. However, we chose not to transform that series into first differences for two reasons. First, because the change in economic growth theoretically is less meaningful than economic growth. Second, because as Enders (1995) indicates, "the issue of whether variables in a VAR need to be stationary exists" (ibid.: 301), given the argument posed by some authors that "the goal of a VAR is to determine the interrelationships among the variables, *not* the parameter estimates" (ibid.: 301; italics in the original).

To implement impulse response functions (IRF) we used a Cholesky decomposition, assuming the following relationships between the individual components of u_t:

$u_{grar,t} = v_{grar,t}$

$u_{dcar,t} = v_{dcar,t} + w_{dcar,grar} \, v_{grar,t}$

$u_{intar,t} = v_{intar,t} + w_{intar,grar} \, v_{grar,t} + w_{intar,dcar} \, v_{dcar,t}$

$u_{emp,t} = v_{emp,t} + w_{emp,grar} \, v_{grar,t} + w_{emp,dcar} \, v_{dcar,t} + w_{emp,intar} \, v_{intar,t}$

Like Tanner (2001), Kamaly and Erbil (2000), and Gochoco-Bautista and Bautista (2002), we consider that domestic credit growth is more "exogenous" than EMP or the interest rate change. We place economic growth above all of them in view of the results of the Granger-causality test (see below), which shows how in the Argentinean case, *GRAR* was the most exogenous of all the variables in the VAR.

Hence, our IRFs will show:

- the effects on *GRAR* of past innovations on *DCAR*, *EMP*, and *INTAR*;

---

[10] BCRA stands for *Banco Central de la República Argentina* (Central Bank of the Republic of Argentina).

- the impact on *DCAR* of current and past shocks to *GRAR* and of past innovations on *EMP* and *INTAR*;

- the impact on *INTAR* of current and past innovations on *GRAR* and *DCAR*, as well as of past innovations on *EMP*;

- the effects on *EMP* of current and past innovations on *GRAR, DCAR*, and *INTAR*.

4.2. Estimation Results

The various tests to determine the number of lags in our VAR showed contradictory results. Also, the results were very sensitive to the maximum order of lags introduced in the tests. Given the inconclusiveness of the tests, we chose to include eight lags, which rendered a stable VAR as well as normal and non-autocorrelated residuals.[11] The summary statistics for the fit of our model follow.

Table 1: Fit of the model

Equation	R-Squared	Chi2	P>Chi2
EMP	0.4759	90.79946	0.0000
DCAR	0.6011	150.681	0.0000
INTAR	0.6251	166.7193	0.0000
GRAR	0.9188	1131.889	0.0000

We used the estimated equation for *EMP* to produce within sample one-step-ahead forecasts for that variable, and we tested the accuracy against a naïve no-change model. The Theil's U calculated yielded a result of 0.7525, confirming the superior explanatory power of the VAR model against a simple naïve no-change.

Starting with the determinants of the exchange market pressure, our system explains 47% of *EMP* (see Table 1). Regarding the exogenous variables, all but *INFDIF* are significant at conventional levels; but only *MBUS* presents the sign expected by the monetary model. A

---

[11] Having performed a Jarque-Bera test for the normality of the residuals, we could not reject the null hypothesis of normality at conventional levels of significance. Also, according to a Lagrange-multiplier test for autocorrelation, we could not reject the null hypothesis of no autocorrelation at conventional levels of significance.

possible explanation for the positive sign of *INTUS* is that a higher interest rate in the US could reduce capital flows to Argentina, therefore rendering a higher *EMP*.

First, what was the impact of domestic credit on EMP? Was it the positive impact predicted by the monetary model and first generation models of currency crises? Or was it the negative impact that could arise when monetary transmission mechanisms have occurred? Allowing for 90% of significance, our IRF results are similar to those in Tanner (2001): a shock to *DCAR* implies a significant and positive response of *EMP* in one period (Figure 2). However, in Argentina there is no evidence that *DCAR* precedes *EMP*, following the Granger-causality test (see Table 2 and Figure 1 for all the results of Granger-causality tests). In spite of the positive effect of domestic credit growth on *EMP* portrayed in the IRF, in our particular case it cannot be said that the monetary transmission could not compensate for the mechanism described in the monetary model. As we shall see, Argentina presented the peculiarity where a credit expansion was harmful to output growth. Hence, an "inverse" monetary transmission mechanism actually reinforced – instead of compensating for – the positive impact of domestic credit on exchange market pressure.

Second, how did the domestic interest rate affect exchange market pressure? Was the impact of *INTAR* on *EMP* positive, as the monetary model and second generation models of currency crises predict? Or was it negative, as is the case when international capital is attracted (expelled) by a higher (lower) interest rate? In our case, an innovation in *INTAR* has a positive and significant effect on *EMP* in two periods (Figure 2). However, *INTAR* does not Granger-cause *EMP*. The only similar case to be found in the literature reviewed above is that of Tunisia (Kamaly and Erbil, 2000). This result suggests that, working through the whole system, a rise in Argentinean interest rates, more than easing pressures against the currency, alerted investors to the eventual need for a devaluation (as in second generation models of currency crises).

Third, can output growth be excluded from an empirical specification of the monetary model? Or does it play a role in the determination of *EMP*? Figure 2 shows that a shock in *GRAR* does affect *EMP* negatively in three periods, thus confirming the relationships portrayed in the monetary model and some second generation models of currency crises

(where worsening fundamentals feed the suspicions on the peg). However, it is also true that in later periods a positive relationship appears, although with lower significance. Besides, the Granger-causality test indicates that *GRAR* precedes *EMP* – *GRAR* is actually the only variable that precedes *EMP* in our system – confirming that output growth may play an even more significant role than monetary policy in some cases, making it difficult to justify an empirical specification of the monetary model that omits it.

Turning to the determinants of domestic credit growth, our system explains 60% of *DCAR* (Table 1). First, we could ask whether the pressure on the currency led the Argentinean monetary authorities to increase credit – that is, to sterilize the loss of reserves in order to preserve enough liquidity in the economic system.[12] An innovation in *EMP* has a (close to significant) positive effect on *DCAR* (Figure 3). Also, according to the Granger-causality test, and like in most studies reviewed above, *EMP* precedes *DCAR*, while the inverse relationship was not true. In sum, monetary authorities did react to exchange market pressures; and the IRF is close to indicating that they sterilized the changes in foreign reserves, probably in order to preserve the liquidity of the economic system. However, the evidence stemming from the IRF is weak, which may be related to the inability of monetary authorities under a currency board to sterilize aggressively, or else to the alternation of attempts to sterilize with a restrictive (hence, defensive) stance.

Second, was there an impact of *INTAR* on *DCAR*? The Granger test shows that changes in interest rates precede domestic credit growth in our system. But the IRF presents mixed results in relation to the sign of such relationship: there are significant positive *and* negative impacts of an innovation to *INTAR* on *DCAR* (Figure 3). Hence, the monetary authorities seem to have been compensating for the lack (excess) of liquidity induced by a rise (decline) in interest rates, as well as reinforcing the monetary contraction (expansion).

Third, did output growth play a role in the determination of monetary policy? If so, was domestic credit management in Argentina pro- or counter-cyclical? Both the IRF and the Granger-causality test suggest that growth did play a role, though again an ambiguous

---

[12] This was the case, for instance, in Mexico (see Flood *et al.*, 1996, and Calvo and Mendoza, 1996).

one. A shock to *GRAR* has a significant and negative effect on *DCAR* in one period, and a positive effect in another (Figure 3). Besides, *GRAR* precedes *DCAR*, according to a Granger-causality test. Given the mixed results of the IRF, it is difficult to draw conclusions about the nature of monetary policy, though given the highest significance of the first positive effect, it seems that domestic credit management was more counter- than pro-cyclical. However, how can that pro-cyclical credit management be explained? In view of other results presented in this work – the positive link between credit growth and EMP and the negative relation between the former and output growth – it is not totally unreasonable that monetary authorities sometimes chose to respond to less (more) GDP growth by reducing (increasing) credit.

Now we turn to the determinants of changes in the domestic interest rate, 62% of which are explained by our system (Table 1). First, we may investigate whether the exchange market pressure had a positive or negative impact on the interest rate: positive as predicted by second generation models of currency crises; or negative as when governments react by lowering (raising) interest rates to compensate for scarce (excessive) external liquidity (an action similar to sterilization via domestic credit management). The IRF shows no significant response of *INTAR* to an innovation on *EMP* (Figure 4). Accordingly, *EMP* does not Granger-cause *INTAR* in our system. This result could be interpreted in terms of the restraints imposed by the currency board: under such regime the monetary authorities could resort neither to protection of the currency via an increase in interest rates nor to "sterilization" of the loss of reserves via a decrease in interest rates. However, an issue for further study could be why the markets did not react to *EMP* by demanding a higher interest rate.

Second, were there liquidity or Fisher effects in Argentina? That is, did expansions in domestic credit bring about lower or higher interest rates? A shock on *DCAR* shows a significant and positive effect on *INTAR* in one period (Figure 4). But the Granger-causality test shows no evidence of *DCAR* preceding *INTAR*. This combination of results are common in the literature (see Tanner, 2001, and the Turkish case in Kamaly and Erbil, 2000). In sum, the Fischer effect appears to prevail in Argentina over the liquidity effect. This could be attributed, as Kamaly and Erbil (2000) do for other countries, to the

traditional high inflation of Argentina, which may make investors demand higher interest rates in the face of domestic credit growth, as they expect inflation – or in this case a likely devaluation – to stem from that credit growth.

Third, was there an impact of output growth on the domestic interest rates? If we take the interest rates to be (at least in part) the result of monetary policy, was this policy pro- or counter-cyclical? If we take them to be the result of market processes, did the weak growth prior to the currency collapse translate into fear of a devaluation, and therefore into higher interest rates? An innovation in *GRAR* has a significant and negative impact on *INTAR* in one period (Figure 4). Also, *GRAR* Granger-causes *INTAR*. Hence, it seems that monetary policy implemented via changes in interest rates was pro-cyclical, as opposed to monetary policy via credit expansion. Also, we could interpret that the markets demanded a higher revenue as a consequence of faltering economic growth and subsequent expectations of devaluation.

Finally, we turn our analysis to the determinants of output growth. Our system explains as much as 91% of *GRAR* (Table 1). However, much of it can be attributed to (lagged) output growth itself, and not to the other variables in our model, as the results of the VAR (not reported) and the Granger-causality test suggest.

First, did *EMP* affect *GRAR*? It could be argued, in a similar fashion to some second generation models of currency crises, that a higher pressure in the exchange rate market is bad for growth: *EMP* is a reflection of either lower net exports or lower net capital inflows; and either of those may slow down economic growth. Was this the case in Argentina? The IRF shows us that an innovation on *EMP* has a significant and negative impact on *GRAR* in two periods (Figure 5). Nevertheless, *EMP* does not Granger-cause *GRAR*. In sum, taking into account all the interactions in the system, the pressures against the currency contributed to the determination of output growth. This somehow shows that Argentina's growth was dependent on the liquidity obtained through external relations (that is, on the evolution of the foreign portion of the monetary supply).

Second, did the aforementioned monetary transmission mechanism play a role? More specifically, did the credit growth prior to the collapse of the currency help economic

growth? Curiously enough, an innovation in *DCAR* has a significant and negative effect on *GRAR* in many periods (Figure 5). However, *DCAR* does not Granger-cause *GRAR*. This result shows an "inverse" monetary transmission mechanism difficult to explain without further research. Nevertheless, some hypotheses could be advanced. On the one hand, it could be that growth was more dependant on foreign liquidity than on domestic liquidity. This idea is somewhat backed by the fact, shown above, that *EMP* had a negative impact on *GRAR*. On the other hand, it could also be argued that the higher credit growth which started around 2001 was insufficient to stimulate output growth, which had been sluggish since approximately 1998.

Third, was there a monetary transmission mechanism from changes in the interest rates? The IRF shows no significant impact of *INTAR* on *GRAR* (Figure 5). Also, the Granger-causality test indicates that *INTAR* did not precede *GRAR*. Hence, output growth was not affected by changes in interest rates – as would occur in some second generation models of currency crises. However, as argued above, this absence of a link between *INTAR* and *GRAR* did not hinder the effects of higher interest rates on *EMP*. Given the many problems that were mounting in Argentina, it is arguable that the rise of interest rates that started in 2001 brought about expectations of even lower growth (or of any other fundamentals-related problem), enough to raise suspicions about the maintenance of the peg, without actually hampering economic activity.

Table 2 : Granger-causality Wald test (Argentina, 1993-2004)

Null hypothesis	chi2	Prob > chi2
DCAR does not Granger-cause *EMP*	9.1975	0.326
INTAR does not Granger-cause *EMP*	12.421	0.133
GRAR does not Granger-cause *EMP*	17.638	**0.024**
All do not Granger-cause *EMP*	55.238	**0.000**
EMP does not Granger-cause *DCAR*	14.199	**0.077**
INTAR does not Granger-cause *DCAR*	28.738	**0.000**
GRAR does not Granger-cause *DCAR*	25.646	**0.001**
All do not Granger-cause *DCAR*	64.204	**0.000**
EMP does not Granger-cause *INTAR*	5.7492	0.675
DCAR does not Granger-cause *INTAR*	12.707	0.122
GRAR does not Granger-cause *INTAR*	14.149	**0.078**
All do not Granger-cause *INTAR*	33.683	**0.090**
EMP does not Granger-cause *GRAR*	9.1772	0.328
DCAR does not Granger-cause *GRAR*	10.091	0.259
INTAR does not Granger-cause *GRAR*	4.5284	0.807
All do not Granger-cause *GRAR*	26.071	0.350

NOTE: In bold, probabilities that allow rejection of the null hypothesis.
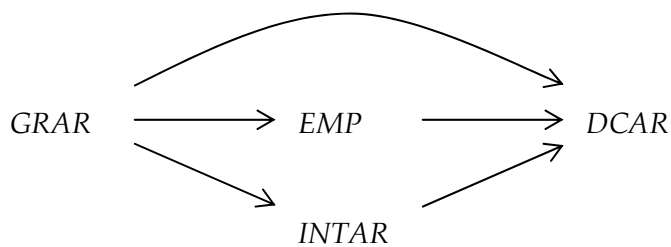
Figure 1. Granger-causality in Argentina, 1993-2004

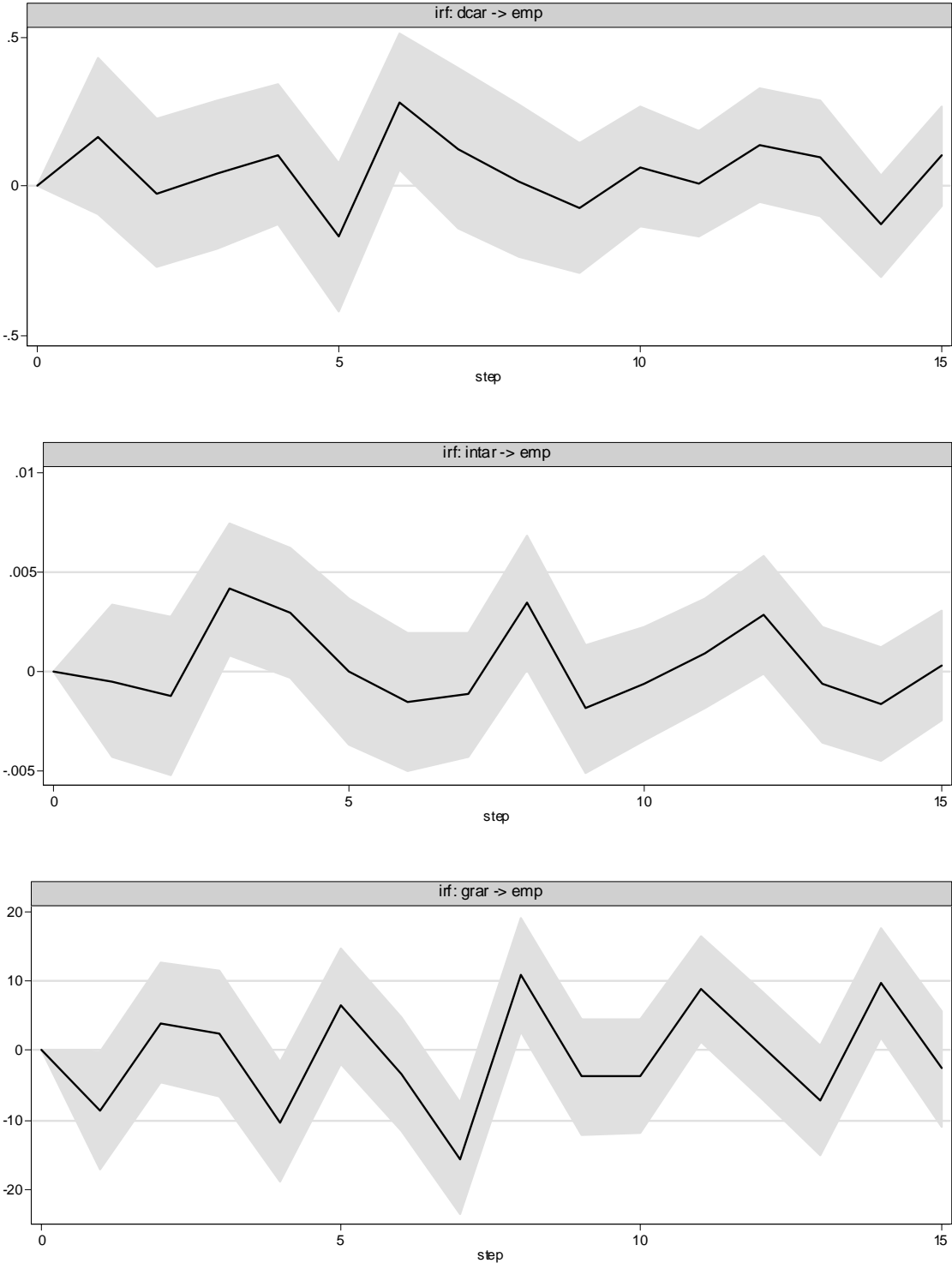**Figure 2. Responses of *EMP* to one-unit shock to *DCAR*, *INTAR*, and *GRAR***

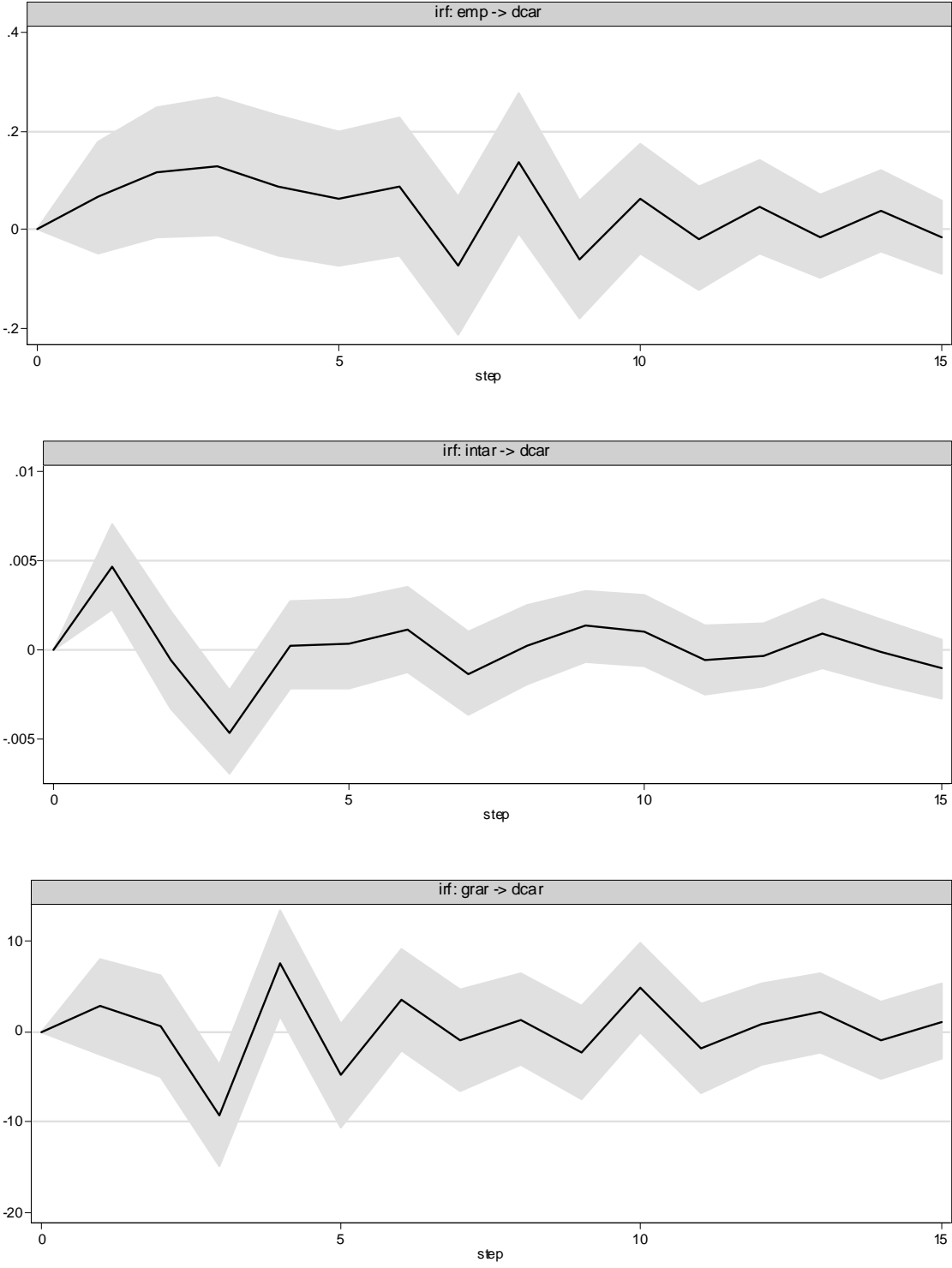**Figure 3. Responses of *DCAR* to one-unit shock to *EMP*, *INTAR*, and *GRAR***

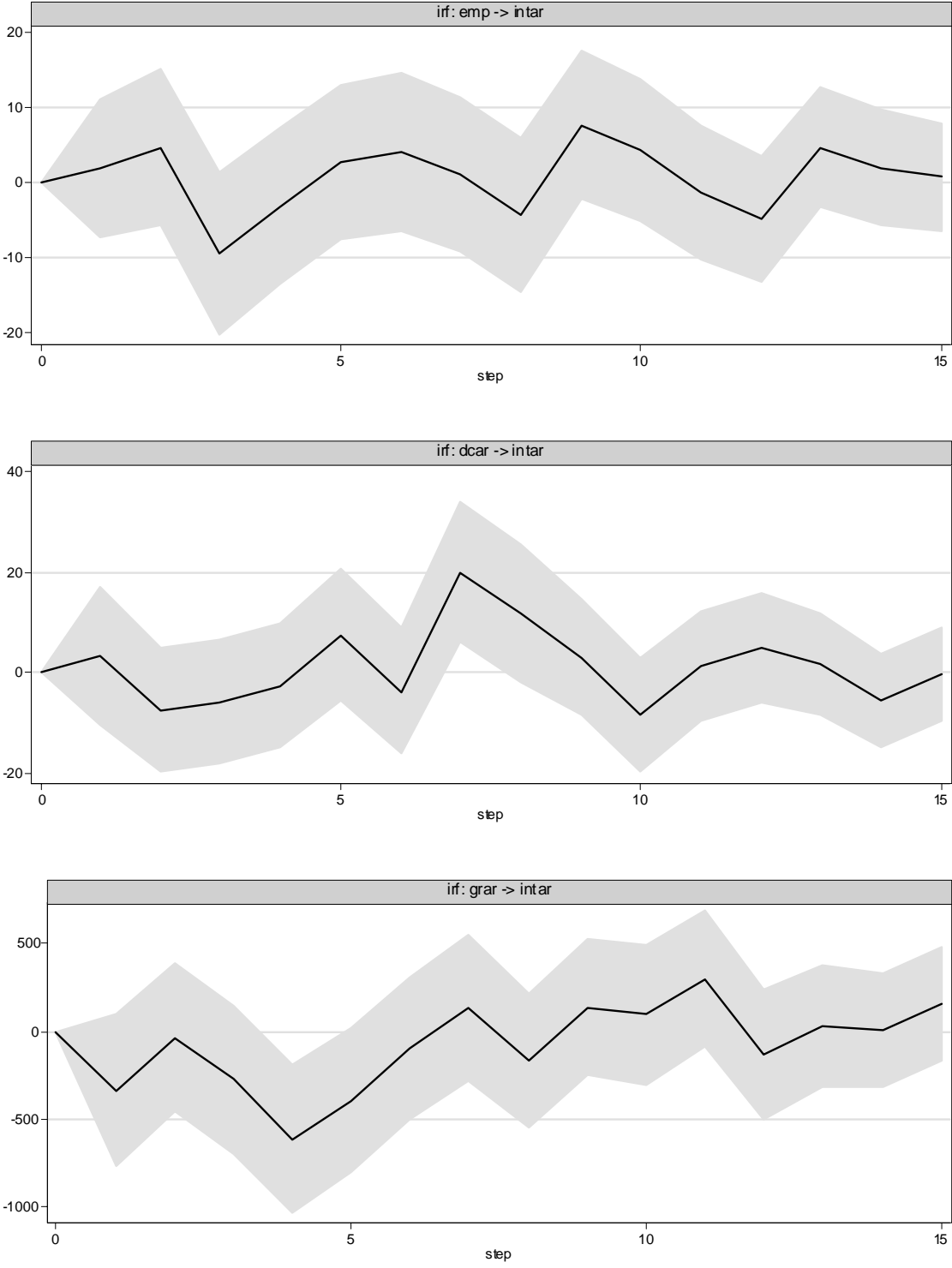**Figure 4. Responses of *INTAR* to one-unit shock to *EMP*, *DCAR*, and *GRAR***
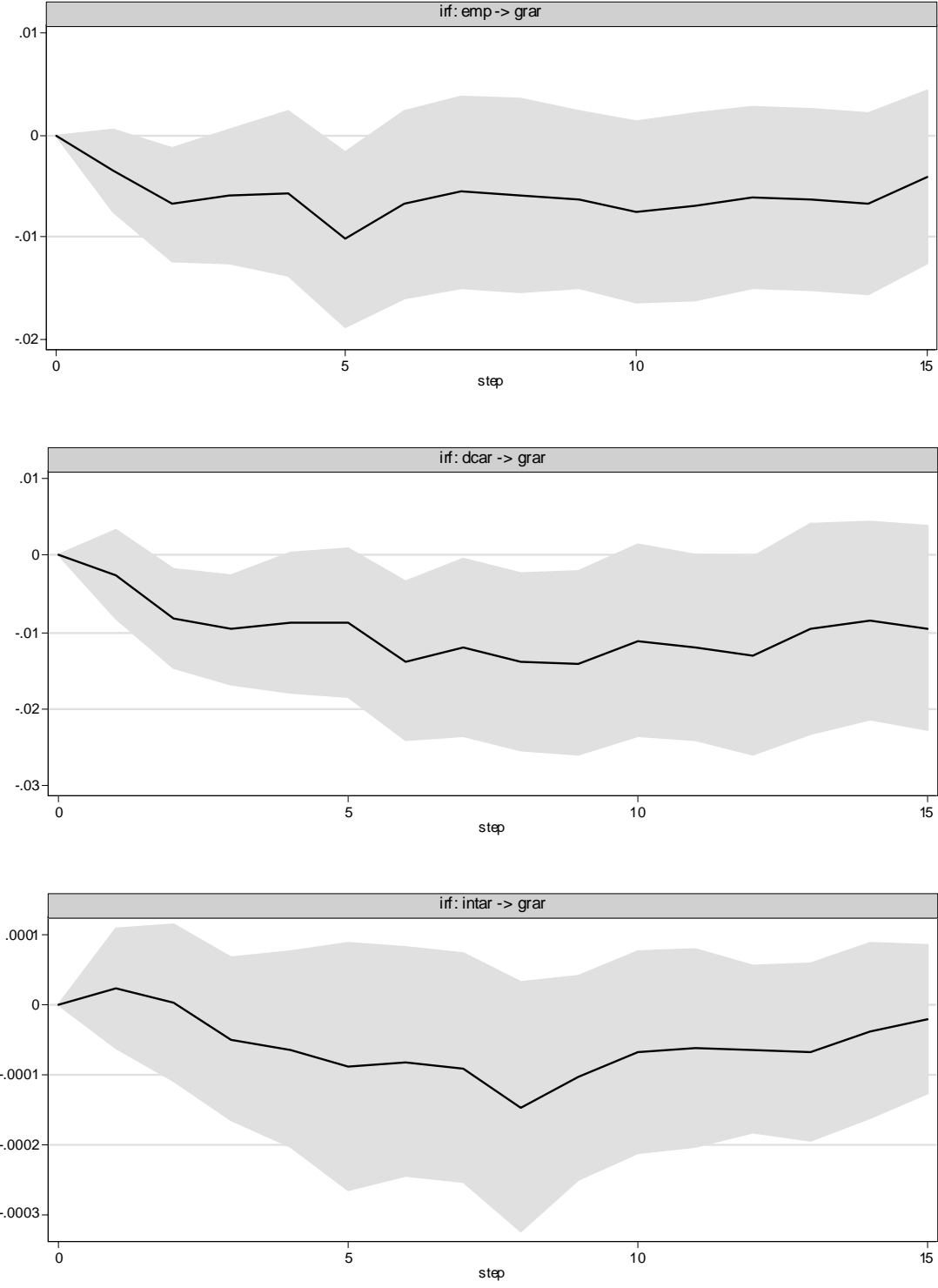
Figure 5. Responses of *GRAR* to one-unit shock to *EMP, DCAR,* and *INTAR*

5. Final Remarks

This paper has tried to contribute to the literature on the interrelations between EMP and monetary policy by focusing on the case of Argentina. But, contrary to a number of other empirical studies utilizing VAR techniques in the same field, we included the effect of economic growth on our target variable, exchange market pressure.

The omission of output growth from empirical studies about EMP is sometimes justified by the lack of monthly data. Nevertheless, in cases where proxies to monthly GDP are available, it may be worthwhile to use them, given powerful reasons provided by theory and certain case studies. On the one hand, traditional monetary models show the inverse relationship between growth and exchange market pressures. On the other hand, some second-generation models highlight the influence of output growth in devaluation expectations (which, in turn, affect EMP). Finally, cases like that of Spain before the European Monetary System crisis, and like the Argentinean crisis (where a deep recession preceded the financial collapse), also reveal the excessive simplification that the omission of growth implies.

Our study supports the need to include growth from econometric tests. First, the Granger-causality test posits economic growth as the most "exogenous" of the variables endogenous to the VAR model. *GRAR* Granger-causes the three other variables. At the other extreme, domestic credit expansion is the most "endogenous" of our four variables, since it does not Granger-cause *GRAR*, *INTAR*, or *EMP*, but is itself Granger-caused by all of them.

Second, the IRFs confirm the relevance of the output growth variable. Nevertheless, the ambiguous influence of *GRAR* on both *EMP* and *DCAR* deserves further investigation. A possible explanation of why monetary policy proved pro-cyclical (in the later periods) is that monetary authorities ended up following the orthodox strategy of trying to promote growth by addressing monetary stability (perhaps in view that responding to sluggish growth with an expansion of credit could increase EMP, which in turn would be bad for growth). The direct relationship between *GRAR* and *EMP* that appears after several periods is more difficult to justify. Perhaps the key lies precisely in the positive relationship between *GRAR* and *DCAR*, evident in latter periods: less growth would, with

time, trigger a pro-cyclical reaction (lower credit expansion), which in turn would ease EMP.

Another decision we made during the modeling stage was not to assume equal interest rate coefficients for both countries. Thus, we were able to show that Argentina's exchange market pressure was negatively affected by an increase in interest rates in *either* of the two countries. In other words, we have observed a direct relationship between *both* US and Argentinean interest rates and EMP. The scenario that such relations present is quite a difficult one for Argentina: raising their own interest rates would not bring about an easing of EMP, but an increase in US interest rates would reduce foreign capital inflows, which in turn would affect EMP.

Also noteworthy is the "anomalous" negative influence of an increase in credit on economic growth. In such a circumstance, the domestic credit management which intended to be counter-cyclical (as was seemingly the case at least as a first reaction) actually turned out to be pro-cyclical. In other words: expansions (reductions) of credit that were implemented as responses to sluggish (strong) economic growth ended up reinforcing the cycle. The reasons why this "anomaly" occurred in Argentina is, clearly, matter for further study. Maybe the explanation lies on the combination of the positive link between *DCAR* and *EMP*, and the negative link between the latter and *GRAR*.

Basically, our results suggest that Argentina's growth was not dependent on internally generated liquidity, but on foreign capital inflows. That is, whether monetary supply changed in response to domestic credit or to international reserves was relevant to economic growth. This conclusion stems from two results of this work. First, the monetary transmission mechanism was not triggered by domestic credit expansion, and was even dampened by the positive link between credit and EMP, together with the negative link between EMP and economic growth. Second, the evolution of international reserves (observed in the evolution of EMP during most of the period under study) did affect growth in the expected sense: an expansion (contraction) of reserves brought about higher (lower) growth.

Furthermore, and according to the IRFs, there are some grounds for arguing that expectations played a role in Argentina in the period under study. First, less (more) growth had an inverse impact on domestic interest rates, which can be interpreted, like in some second-generation models of crises, as the result of increasing (decreasing) devaluation expectations. Second, devaluation expectations are also one of the possible explanations for the positive influence of domestic interest rates on EMP.

To sum up, the positive link between US interest rates and EMP, together with the likely role of expectations, and the dependence of growth upon externally generated liquidity yield two possible outcomes for the Argentinean economy.[13] One was that of the years of stability, where higher growth and lower EMP reinforced each other; interest rates remained moderate as a consequence of healthy output; and moderate credit growth helped the virtuous circle by not creating inflation or devaluation expectations. The other cycle was that of the buildup to the currency collapse, where lower growth and a higher EMP reinforced each other; interest rates ended up increasing as a result of sluggish growth; and a higher domestic credit growth, far from helping stop the vicious circle, reinforced it by feeding inflation and devaluation expectations. Further exploration of the structure of the Argentinean economy – and especially the linkage between its financial and productive systems, and their relation/dependency with external capital inflows – is needed to understand the existence of these two possible outcomes.

Finally, even if there are signs of a role of expectations, there are also signs of policy weaknesses: signs of the incapability of monetary authorities under a currency board to sterilize aggressively, or of the alternation of attempts to sterilize with a more "orthodox" defensive stance. Also, no clear monetary strategy exists in face of changing interest rates: the monetary authorities seemed to have been compensating for the lack (excess) of liquidity induced by a rise (decline) in interest rates, as well as reinforcing the monetary

---

[13] This outcomes are similar to what some crises models identified as equilibria: however, we have not formally tested for multiple equilibria, as in the sense of those models. Also, we prefer not to refer to the two possible cycles as equilibria in order to eliminate the connotation of stability: the experience of Argentina itself has shown that the virtuous cycle was unstable and that the vicious one turned out to be explosive.

contraction (expansion). The nature and determinants of this lack of a unique strategy for monetary policy also deserves further study.

References

Álvarez Plata, Patricia and Mechthild Schrooten (2003a): "Mis-Leading Indicators? The Argentinean Currency Crisis", Discussion Paper 327, DIW Berlin (German Institute for Economic Research), February.

Álvarez Plata, Patricia and Mechthild Schrooten (2003b): "The Argentinean Currency Crisis: A Markov-Switching Model Estimation", Discussion Paper 348, DIW Berlin (German Institute for Economic Research), May.

Bustelo, Pablo, Clara García and Iliana Olivié (2000): "Global and Domestic Factors of Financial Crises in Emerging Economies: Lessons from the East Asian Episodes", in *Social Science Research Network* (*SSRN*), Social Science Electronic Publishing, New York, January.

Bustelo, Pablo (2004): "Las crisis financieras en Asia y en Argentina: Un análisis comparado", *Información Comercial Española. Revista de Economía*, 816, July-August, pp. 61-74.

Calvo, Guillermo A. and Enrique Mendoza (1996): "Mexico's Balance of Payments Crisis: A Chronicle of a Death Foretold", *Journal of International Economics*, 41:3-4, pp. 235-264.

Calvo, Guillermo A. (2000): "Balance of Payments Crises in Emerging Markets. Large Capital Inflows and Sovereign Governments", in Krugman, Paul (ed.): *Currency Crises*, University of Chicago Press, Chicago, Illinois, pp. 71-104.

Chang, Roberto and Andrés Velasco (1998): "Financial Crises in Emerging Markets: A Canonical Model", Working Paper 98-10, Federal Reserve Bank of Atlanta, July.

Cole, Harold L. and Timothy J. Kehoe (1996): "A Self-Fulfilling Model of Mexico's 1994-1995 Debt Crisis", *Journal of International Economics*, 41:3-4, pp. 309-330.

Cole, Harold L. and Timothy J. Kehoe (1998): "Self-Fulfilling Debt Crises", Staff Report 211, Research Department, Federal Reserve Bank of Minneapolis, July.

Connolly, Michael B. and Dean Taylor (1984): "The Exact Timing of the Collapse of an Exchange Rate Regime and Its Impact on the Relative Price of Traded Goods", *Journal of Money, Credit and Banking*, 16:2, pp. 194-207.

Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz (1994): "Speculative Attacks on Pegged Exchange Rates: an Empirical Exploration with Special Reference to the European Monetary System", Working Paper 4898, National Bureau of Economic Research, October.

Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz (1995): "Exhange Market Mayhem: the Antecedents and Aftermath of Speculative Attacks", mimeo., UC Berkeley and INSEAD, June.

Enders, Walter (1995): *Applied Econometric Time Series*, John Wiley and Sons, New York.

Flood, Robert P. and Peter M. Garber (1984): "Collapsing Exchange Rate Regimes: Some Linear Examples", *Journal of International Economics*, 17:1-2, pp. 1-13.

Flood, Robert P., Peter M. Garber and Charles Kramer (1996): "Collapsing Exchange Rate Regimes: Another Linear Example", *Journal of International Economics*, 41:3-4, pp. 223-234.

Gochoco-Bautista, Maria Socorro and Carlos C. Bautista (2002): "Monetary Policy and Exchange Market Pressure: the Case of the Philippines", mimeo., University of the Philippines (forthcoming in 2005 in *Journal of Macroeconomics*).

Girton, Lance and Don Roper (1977): "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience", *The American Economic Review*, 67:4, pp. 537-548.

Hausmann, Ricardo and Andrés Velasco (2002): "The Argentine Collapse: Hard Money's Soft Underbelly", mimeo., Kennedy School of Government, Harvard University, April.

Kamaly, Ahmed and Nese Erbil (2000): "A VAR Analysis of Exchange Market Pressure: A Case Study for the MENA Region", Working Paper 2025, Economic Research Forum.

Kaminsky, Graciela, Saul Lizondo and Carmen M. Reinhart (1997): "Leading Indicators of Currency Crises", Policy Research Working Paper 1852, World Bank, November.

Kaminsky, Graciela (2003): "Varieties of Currency Crises", Working Paper 10193, National Bureau of Economic Research, December.

Krugman, Paul (1979): "A Model of Balance-of-Payments Crises", *Journal of Money, Credit and Banking*, 11:3, pp. 311-325.

Mussa, Michael (2002): *Argentina and the Fund: From Triumph to Tragedy*, Institute for International Economics, Washington DC.

Obstfeld, Maurice (1994): "The Logic of Currency Crises", Working Paper 4640, National Bureau of Economic Research, September.

Obstfeld, Maurice (1996): "Models of Currency Crises with Self-Fulfilling Features", *European Economic Review*, 40:3, pp. 1037-1047.

Ozkan, F. Gulcin and Alan Sutherland (1995): "Policy Measures to Avoid a Currency Crisis", *The Economic Journal*, 105:429, pp. 510-519.

Perry, Guillermo and Luis Servén (2003): "The Anatomy of a Multiple Crisis: Why Was Argentina Special and What Can We Learn From It?", Policy Research Working Paper 3081, World Bank, June.

Tanner, Evan (2001): "Exchange Market Pressure and Monetary Policy: Asia and Latin America in the 1990s", IMF Staff Paper, 47:3, pp. 311-333, International Monetary Fund.

De la Torre, Augusto, Eduardo Levy Yeyati and Sergio L. Schmukler (2003): "Living and Dying with Hard Pegs: The Rise and Fall of Argentina's Currency Board", mimeo., World Bank and Universidad Torcuato Di Tella, January.

Appendix

The variables r_a and $\dot{e}$, which compose EMP_t, were calculated as follows:
- r_a is the change in international reserves divided by lagged monetary base. International reserves were obtained from line 1L from the IFS; and monetary base is line 14 from the IFS.
- $\dot{e}$ is the rate of change of the official exchange rate, measured in dollars per peso. The official exchange rate is the inverse of line RF from the IFS.

DCAR is the change in the domestic credit provided by monetary authorities divided by lagged monetary base. Domestic credit was obtained from the sum of lines 12A, 12E, and 12F from the IFS. Monetary base was, again, line 14 from the IFS.

INTAR is the change in an interest rate index. The index was calculated by adding the three first principal components extracted from seven interest rate series (deposit and monetary market interest rates), obtained from the BCRA.

GRAR was obtained from INDEC's *Índice de Actividad Económica* (Index of Economic Activity), which was transformed as follows: first, we adjusted the monthly series for seasonality, using a symmetric moving average; second, we calculated the rate of change of the seasonally adjusted monthly series.

INFDIF is the result of subtracting US inflation from Argentina's inflation, and then adding $\dot{e}$. Inflation rates were obtained by calculating the rate of change of Consumer Price Indexes (which were taken from INDEC and Bureau of Labor Statistics).

GRUS is the rate of change of US GDP. The monthly GDP series was built by linear interpolation from the quarterly data of a seasonally adjusted index of GDP. This index was obtained from the line 99BVRZF from the IFS).

MBUS is the rate of change of the US monetary base (line 14 from the IFS).

INTUS is the change in an interest rate index. The index is the first principal component extracted from 6 interest rate series (deposit, monetary market, treasury bills, and lending rates). All the series were taken from the IFS.