Transmission of External and Internal Shocks In Argentina During The Convertibility Period. Some Empirical Findings From VARs

Chris GEIREGAT[1]
(Williams College)

July 2004

ABSTRACT

We use VARs to study the transmission of shocks in Argentina during the currency board regime. We focus on shocks to international commodity prices, U.S. monetary policy, the real effective exchange rate, and the sovereign risk premium on emerging market debt. Of those factors, only the sovereign risk premium affects output significantly, which we believe is really a proxy for beliefs about fiscal solvency. Both the monetary base and money market interest rates react to U.S. monetary policy, but such shocks do not affect Argentine output significantly. Finally, it does not appear that the appreciation of the U.S. dollar affected the economy adversely.

Keywords: International Transmission; Argentina; Currency Board; Monetary Policy.

JEL classification: C32; E52; F41.

[1] This paper was finished when the author was a visitor at the IMF Institute. We thank participants at the IMF Institute lunch seminar and the Williams College brown bag lunch for helpful comments. Peter Montiel and Niamh Sheridan are gratefully acknowledged for their specific suggestions. All errors are those of the author alone.

1. Introduction

The adoption by the Argentine authorities of the one-for-one peso/dollar currency board regime in 1991 signaled a drastic departure from the previously failed attempts at economic stabilization and reform. By having monetary policy tied to that of the U.S., it was argued, a credible hard peg would rapidly anchor expectations and would provide some of the necessary conditions for achieving a balanced growth path. The tight standard for monetary policy was followed by a new charter for the central bank that formally established its independence and by a reduction in the barriers to capital flows. The new regime also ushered in a period of market-oriented reforms, especially in the financial sector. Growth picked up and, after a transition period, inflation was reduced into single digits. As the macroeconomic environment stabilized and the country withstood the fallout from the Mexican Tequila crisis, Argentina's choice of a hard peg gained further credibility. However, after the initial years of strong growth, a period of protracted stagnation followed. Ultimately, during 2001-2002 the country was thrown into political and economic turmoil, and the currency board regime was abandoned.

In this paper, we pick up the empirical question how strongly shocks, and external shocks in particular, are transmitted in an economy that operates under a currency board. The textbook open macro treatment of a small economy that operates under a hard peg regime with few barriers to capital flows predicts that such shocks are transmitted quite strongly, essentially because the monetary authority has neither the exchange rate instrument nor domestic credit policy (open market operations) available to lean against the wind. Consequently, if domestic prices do not have enough (downward) flexibility, then adverse shocks might lead to protracted downturns. To address this question empirically, we use monthly data from Argentina to estimate a 'semi-structural' VAR model that includes prices, output, the interest rate and money as key domestic variables, in addition to four variables that we consider to largely 'external' in origin. These four external sources of business cycle variation are: international commodity prices, U.S. monetary policy actions, real exchange rate shocks, and finally the external borrowing premium for emerging economies. To identify the empirical model, we impose a set of short-run identification restrictions that are quite standard in the VAR literature, applied to the particular case of a small country that has adopted a currency board regime. This approach allows us to capture some features of the currency board regime while keeping the model parsimonious enough that it can be estimated with only nine years of monthly observations.

There are at least three reasons why an empirical analysis of the transmission of shocks into Argentina is relevant. First, we contribute to a growing literature that documents evidence on the international transmission of innovations in monetary policy – and shocks to U.S. monetary policy in particular. So far, most of this literature has focused on the transmission across large economies with floating currencies, such as the G-7 countries. For example, Eichenbaum and Evans (1995) report that U.S. monetary policy contractions lead to persistent nominal and real appreciations of the dollar (against five major currencies), and increase short-term interest rates more in the U.S. than abroad. Kim and Roubini (2000) also study the response to a contractionary U.S. monetary policy action by the economies of the non-U.S. G-7 members. They find that in those countries, short-term interest rates tend to increase, monetary aggregates decrease (except in France and Japan), prices initially rise (except in UK), and exchange rates depreciate initially with later evidence of overshooting. However, variation in U.S. monetary policy generally explains little of the variation in domestic industrial production (in the order of 3-10 percent), except for Canada. Kim (2001) reaches similar conclusions in a study that includes a wider range of macroeconomic indicators. Argentina's hard peg to the dollar offers another opportunity to look at the degree to which monetary policy is transmitted internationally. More concretely, we ask the question: Did U.S. monetary policy shocks transmit into the Argentine economy? And if so, how strongly were these shocks transmitted? The answers to these questions do not only complement findings from previous research, they may also help our understanding of how to weigh the costs of surrendering the monetary policy option against its benefits, particularly in light of the Federal Funds Rate tightening of the late 1990s.

The second motivation for focusing on external shocks – in addition to U.S. monetary shocks – is that that there is evidence that such shocks are important sources of business cycle variation. Kim and Roubini (2000) report that external shocks alone easily explain more than one third of the variation in output for the non-U.S. G-7 economies, particularly over the medium run. How does this finding extend to Argentina? What types of external shocks were particularly potent? Indeed, by maintaining a hard peg, Argentina could have left itself more vulnerable to such shocks than countries that opted for more flexible exchange rate arrangements (Brazil and Mexico, for example).

Third and finally, there has been considerable debate on what led to the economic crisis of 2001-2002 and the subsequent collapse of the currency board.[2] The usual suspects and accomplices include but are not limited to: inflexibility of currency board regime, fixing the peso to the wrong currency, lack of fiscal discipline, labor market inflexibility, a debt-deflation spiral, and the fallout of adverse external events in the latter half of the 1990s. For example, de la Torre, Levy Yeyati and Schmukler (2003) argue that the country fell into a currency-growth-debt trap and claim that "the trap was in no small part due to major external shocks" (p. 8). On the other hand, Perry and Servén (2002) concluded that "Argentina was not hit harder than other Latin American countries by the terms of trade decline after the Asian crisis, nor by the US and worldwide slowdown in 2001, nor by the capital flows reversal and the rise in spreads after the Russian crisis. As a consequence, the fact that Argentina did worse than other countries after 1999 must be attributed to her higher vulnerabilities to shocks, weaker policy responses or a combination of both." (p. 3) We do not have much confidence in the ability of a VAR methodology to directly analyze the 2001-2002 collapse or to identify specific 'suspects'. However, VAR impulse response functions can provide empirical evidence on how strongly the domestic economic variables respond to various types of shocks, and variance decompositions provide some measure for assessing

[2] For example, see The Economist (2002), Hausman and Velasco (2002), Mussa (2002), Perry and Servén (2002), and de la Torre, Levy Yeyati and Schmukler (2003), among others.

the relative importance of those sources of business cycle variation. In that sense, our findings can complement other types of research and offer additional insights.

The rest of the paper is organized as follows. The second section describes and motivates the choice of variables that we use in the estimation. It also discusses a convenient decomposition of the real exchange rate. In section three, the VAR methodology and the identification restrictions are discussed in detail. Section four reports the main findings of the estimations, based on the variance decompositions and impulse responses. Section five continues to discuss the empirical results and concludes.

2. The Data

This section describes the data that is used in the estimations. We have monthly observations on a vector of macroeconomic variables over the period 1993:01 through 2001:02, which covers most of the currency board period. We exclude the first few months of the currency board regime (that is, those months in 1991-1992) to allow the initial adjustment of the economy towards the new regime to take effect. We also exclude the observations towards the end of the hard peg regime, since the final months of the currency board regime were marred by increased political and economic uncertainty and eventually a full-blown crisis.

Our data vector takes the following variables: {*P*, *Y*, *MMR*, *M*, *FFR*, *COM*, *JPM, ER*}.[3] The main domestic variables of interest are prices P, output Y, the money market interest rate MMR, and the monetary aggregate M. The additional variables are: the U.S. Federal Funds Rate FFR, an international commodity price index COM, a measure of the sovereign risk spread JPM, and finally a real exchange rate measure ER. We now describe each of these variables in more detail. The variables P and Y are the consumer price index and index of industrial production respectively (with base year 1995). Although broader measures of prices and output might be preferable, the availability of monthly frequencies determined our choice. Next, the variable MMR is the money market interest rate, and M is the monetary base. We use the monetary base instead of broader money measures such as M_1 or M_2 because the design feature of the currency board regime implies that domestic authorities give up control over high-powered money. Broader measures of money may be affected by shocks to the monetary base *and* by other factors, including the institutional changes in the financial sector and other money velocity shocks. We leave for future research the effects of the currency board regime on broad money or credit measures.

We now describe the other, 'external' variables, beginning with the Federal Funds Rate (FFR). There are several reasons why we include U.S. monetary policy in our model. First, we already mentioned empirical studies that U.S. monetary policy actions affect other

[3] Unless otherwise indicated, the data is taken from the IMF International Financial Statistics (IFS) database.

economies. Second, movements in U.S. interest rates, and changes in the stance of U.S. monetary policy in particular, are likely to be relevant to Argentina because of its hard peg to the dollar combined with free capital mobility. This leaves open the question of why we use *FFR*. Bernanke and Blinder (1992) provide strong arguments that the Federal Funds Rate is a good measure of the stance of U.S. monetary policy. Furthermore, we believe that *FFR* serves is a good measure of 'the U.S. interest rate' since other U.S. money market rates follow movements in the Federal Funds rate closely.

Next, we include in our specifications an index of international commodity prices (*COM)*. We include this variable because it may capture supply shocks as well as serve as a proxy for future inflation. It is well known in the VAR literature that so so-called 'price puzzle' (in which contractionary monetary policy shocks increase the price level) disappears when a variable that proxies for future inflation is included in the specification.[4] We follow the literature and give *COM* a non-zero contemporaneous coefficient in the Federal Funds Rate equation. We also allow domestic prices to be affected by *COM.* By doing so, we feel more confident that shocks to the Federal Funds Rate truly represent innovations in U.S. monetary policy, rather than an endogenous reaction that may affect Argentina through other channels as well.

A third source of variation that we include in our empirical model comes from *JPM*, the JP Morgan sovereign spread of the EMBI emerging markets bond index.[5] Most generally, *JPM* may contain information about the international capital markets' assessment of the health of emerging economies in general, and their budgetary accounts in particular. Because a fraction of the emerging market debt was issued by Argentina, variation in this index has external and domestic components.[6] Variation in *JPM* that has external origins may include the Mexican peso and Brazilian *real* crises and the Russian default. In spite of their foreign origins, those events may increase the scrutiny of Argentina's public finances and change the outlook of its sustainability. Alternatively, some of the information contained in *JPM* may be domestic in nature, such as new economic and political developments or an IMF report. In summary, although we cannot be sure about the exact origins of the shocks to *JPM* (whether domestic or foreign), we view variation in the index largely as a proxy for changes in the budgetary outlook. Thus, we include *JPM* in our VAR specifications to analyze how the domestic variables are affected by such changes.

---

[4] For example, see Sims (1992).

[5] This index is available from Bloomberg.

[6] Ideally, we wish to separate out domestic influences from external ones, but indexes that exclude Argentina were not available for the entire sample period (it is hard to argue that such separate components would be orthogonal anyway). Instead, we allow for contemporaneous interaction in the VAR model.

The final variable that needs explaining is the real effective exchange rate ER. We define the real effective exchange rate for Argentina ($REER_{Arg}$) as follows:

$$(1) \qquad REER_{Arg} \equiv \left(\frac{e_0.P_{Arg}}{P_{USA}}\right)^{\alpha_0} . \left(\frac{e_1.P_{Arg}}{P_1}\right)^{\alpha_1} \ldots . \left(\frac{e_n.P_{Arg}}{P_n}\right)^{\alpha_n}$$

In this expression, P_{Arg} and P_{USA} are the price levels of Argentina and the U.S. respectively, e_0 is the nominal dollar/peso exchange rate (equal to one during 1991-2001) and α_0 is the share of Argentina's trade that with the U.S. The P_i, e_i, and α_i have the same interpretation, but applied to the $i = 1,\ldots,n$ *other* trading partners. The trade weights sum to one, that is: $\alpha_0 + \alpha_1 + \ldots + \alpha_n = 1$, and are calculated as the fraction of each country in Argentina's total imports plus exports. The e_i are expressed in terms of foreign currency per peso. We express the real exchange rate as an index with base 1995 = 100. Note that, as defined, an *appreciation* in the real exchange rate shows up as an *increase* in the index. How much of the variation in $REER_{Arg}$ is due to the hard peg with the dollar? To answer this question, we decompose $REER_{Arg}$ into parts that capture the link of the peso to the dollar, and parts that capture other sources of real exchange rate variation. To do this, we first define $REER_{USA}$, the real effective exchange rate for the U.S.:

$$(2) \qquad REER_{USA} \equiv \left(\frac{s_0.P_{USA}}{P_{Arg}}\right)^{\beta_0} . \left(\frac{s_1.P_{USA}}{P_1}\right)^{\beta_1} \ldots . \left(\frac{s_n.P_{USA}}{P_n}\right)^{\beta_n}$$

In $REER_{USA}$, the nominal exchange rates (foreign currency per dollar) are denoted by s, and the trade weights by β (with $\beta_0 + \beta_1 + \ldots + \beta_n = 1$).[7] It is easy to show that $REER_{Arg}$ can be decomposed as follows:

$$(3) \qquad REER_{Arg} = REER_{USA\backslash Arg}.RER_{ArgUSA}.REER_{Arg-USA}$$

with

$$(4) \qquad REER_{USA\backslash Arg} \equiv \left(\frac{s_1.P_{USA}}{P_1}\right)^{\beta_1} \ldots . \left(\frac{s_n.P_{USA}}{P_n}\right)^{\beta_n}$$

[7] The α and β trade weights were calculated as each trading partner's share in total imports plus exports of Argentina and the U.S. respectively (averages over the sample period), using Directions of Trade Statistics data on 38 major trading partners.

(5) $$RER_{ArgUSA} \equiv \frac{e.P_{Arg}}{P_{USA}}$$

(6) $$REER_{Arg-USA} \equiv \left(\frac{e_0.P_{Arg}}{P_{USA}}\right)^{\alpha_0-\beta_0} . \left(\frac{e_1.P_{Arg}}{P_1}\right)^{\alpha_1-\beta_1} \ldots . \left(\frac{e_n.P_{Arg}}{P_n}\right)^{\alpha_n-\beta_n}$$

Thus, we find that $REER_{Arg}$ is decomposed into three parts. The first part is $REER_{USA\backslash Arg}$, defined as the U.S. real effective exchange rate *excluding* Argentina. Because Argentina is a small trading partner for the U.S. (about 0.5 percent) this term is essentially the U.S. real effective exchange rate. The second part in the decomposition of $REER_{Arg}$ is RER_{ArgUSA}, which is simply the bilateral real exchange rate between Argentina and the U.S. During the currency board period $e_0 = 1$, thus variation in RER_{ArgUSA} merely reflects inflation differentials. Finally, the third term in the $REER_{Arg}$ decomposition is $REER_{Arg-USA}$. This term is similar to $REER_{Arg}$, but now each trading partner *j* is given a weight $\alpha_j - \beta_j$ ($j = 0, \ldots, n$).

How do we interpret $REER_{Arg-USA}$? Suppose first that Argentina's trade patterns resemble those of the U.S. In that case, $\alpha_j - \beta_j \approx 0$ and therefore $REER_{Arg-USA} \approx 1$. In that case, movements in $REER_{Arg}$ will closely resemble those of $REER_{USA}$. In particular, any movements due to dollar fluctuations will affect both the U.S. and Argentina real effective in similar ways. If on the other hand, $\alpha_j - \beta_j \neq 0$ and thus both countries have very different trade patterns, then $REER_{Arg-USA} \neq 1$. In that case, exchange rate shocks will affect $REER_{Arg}$ in ways quite different from $REER_{USA}$. To put it differently, the term $REER_{Arg-USA}$ captures the variation in $REER_{Arg}$ that stems from the extent to which Argentina's foreign trade patterns differ from those of the U.S., the anchor country. Furthermore, since the hard peg regime is a nominal anchor that prevents Argentina from using the exchange rate instrument to adjust to shocks with its major trading partners, $REER_{Arg-USA}$ may be interpreted as a 'mismatch measure' for the hard peg. Table 1 shows, for both countries, the top five foreign trade partners over the sample period. It is clear that there are indeed substantial differences in the foreign trade patterns of both countries. For example, while the top five trading partners for the U.S. add to 52.3 percent of that country's foreign trade, those same countries have a combined trade share of only 12.7 percent in Argentina. Conversely, Argentina's top five trading partners (excluding the U.S. itself) have a 41.4 percent share in overall trade, accounting for only 9.1 percent of U.S. trade. Bilateral trade between Argentina and the U.S. accounts for 15 percent and 0.5 percent respectively of those countries' overall foreign trade.

[Insert Table 1 here]

Of course, not only do differences in trade patterns matter, but also the size of the shocks to the various countries will affect how closely $REER_{Arg}$ follows $REER_{USA}$. Figure 1 shows the evolution of $REER_{Arg}$ against its three subcomponents, each expressed as an index with base 1995 = 100, and calculated over the period 1992-2001. It is quite clear from Figure 1 that, although overall $REER_{Arg}$ appears to have appreciated along with $REER_{USA\backslash Arg}$, there are significant deviations over the sample period. In particular, the real depreciation during 1994-1995 and the appreciation in 1999 are captured by variation in $REER_{Arg-USA}$. We report estimates that use $REER_{Arg}$ and $REER_{USA\backslash Arg}$ as measures of *ER*.

[Insert Figure 1 here]

This completes the description of the data vector. In the next section we discuss in detail the VAR methodology and our identification assumptions.

3. The Empirical Model

3.a. VAR Methodology

We are interested in estimating the following *structural model* in *n* variables **y** with *p* lags, denoted *SVAR(p)*:

(7) $$\mathbf{B_0}.\mathbf{y_t} = \mathbf{b} + \mathbf{B_1}.\mathbf{y_{t-1}} + \ldots + \mathbf{B_p}.\mathbf{y_{t-p}} + \varepsilon_\mathbf{t} \quad \Leftrightarrow \quad \mathbf{B}(L).\mathbf{y_t} = \mathbf{b} + \varepsilon_\mathbf{t}$$

with $\mathbf{B}(L) \equiv [\mathbf{B_0} - \mathbf{B_1}.L^1 - \ldots \mathbf{B_p}.L^p]$, and *L* the lag operator. The matrix $\mathbf{B_0}$ contains the contemporaneous coefficients of the model, $\mathbf{b}$ is a vector of constants, the $\mathbf{B_j}$ contain the coefficients on the *p* lags of $\mathbf{y}$ (for $j = 1, \ldots, p$), and $\varepsilon_\mathbf{t}$ is a vector of structural disturbances with $E[\varepsilon_\mathbf{t}] = \mathbf{0}$ and $E[\varepsilon_\mathbf{t}.\varepsilon_\mathbf{t}^{'}] = \mathbf{I_n}$. One may think of the SVAR(*p*) representation as a linear approximation to some theoretical model. Note that we immediately impose the structural errors to be pair wise orthogonal and to have unit variance. As defined, a one-unit shock to any of the variables is a shock of a one-standard deviation magnitude, or a 'typical' shock. Premultiplication of the SVAR(*p*) model by $(\mathbf{B_0})^{-1}$ yields the *reduced-form model* or *VAR(p)* representation of the model:

(8) $$\mathbf{y_t} = \mathbf{a} + \mathbf{A_1}.\mathbf{y_{t-1}} + \ldots + \mathbf{A_p}.\mathbf{y_{t-p}} + \mathbf{u_t}$$

In the VAR(*p*) representation of the empirical model, $\mathbf{a} \equiv (\mathbf{B_0})^{-1}.\mathbf{b}$ is a vector of constants, the $\mathbf{A_j} \equiv (\mathbf{B_0})^{-1}.\mathbf{B_j}$ contain the reduced-form coefficients on the *p* lags of **y** (for $j = 1, \ldots, p$), and $\mathbf{u_t} \equiv (\mathbf{B_0})^{-1}.\varepsilon_\mathbf{t}$ is the vector of reduced-form disturbances with $E[\mathbf{u_t}] = \mathbf{0}$ and

$E[\mathbf{u_t}.\mathbf{u_t}'] \equiv \Omega = (\mathbf{B_0})^{-1}.[(\mathbf{B_0})^{-1}]'$. Next, it is convenient and customary to address the dynamic responses of the system to a structural shock by tracing out the *impulse-responses*. The impulse responses are obtained from the *VMA(∞)* representation of the model:

(9) $\mathbf{y_t} = \mathbf{c} + \mathbf{C}(L).\varepsilon_\mathbf{t}$

In the VMA(∞) representation, $\mathbf{c} \equiv (\mathbf{B}(L))^{-1}.\mathbf{b}$ is a vector of constants and $\mathbf{C}(L) \equiv [\mathbf{B}(L)]^{-1}$ contains the impulse response coefficients. Finally, we report the results of the *historical variance decomposition*, which shows that fraction of the variation that is due to variation in each of the respective variables of the model.[8]

The VAR(*p*) includes only lagged endogenous variables, and thus the reduced form of the model can be estimated consistently by OLS. However, since the estimate for Ω contains only $n.(n+1)/2$ distinct elements, this is the maximum number of free parameters that can be used to retrieve the coefficients of $\mathbf{B_0}$. The literature has solved this identification problem in different ways, including by imposing short-run and/or long-run restrictions. In our study we impose only short-run restrictions on $\mathbf{B_0}$, as this allow us avoid the problem of having to impose long-run restrictions with less than ten years of monthly observations.[9] In addition, as will become clear below, our restrictions have a simple theoretical interpretation and do not impose too much structure on the model. Note also that since $\mathbf{u_t} \equiv (\mathbf{B_0})^{-1}.\varepsilon_\mathbf{t}$ it follows that $\varepsilon_\mathbf{t} \equiv \mathbf{B_0}.\mathbf{u_t}$. Thus, we interpret the restrictions in terms of *innovations* rather than restrictions on the *levels* of the variables. Since $\mathbf{B_0}$ has been given ones on its diagonal axis, we have $n.(n-1)/2$ necessary identification restrictions for the model to be identified. A popular approach has been to constrain $\mathbf{B_0}$ to be lower triangular. However, it is well known that the inferences drawn from such a recursive system are not invariant to the ordering of the variables, and it is often hard to give such models a structural interpretation. Since Bernanke (1986) and Sims (1986), nonrecursive exclusion restrictions on $\mathbf{B_0}$ have been widely used. Next we discuss the identification restrictions in more detail.

3.b. Identification of the Empirical Model

In this section we discuss our basic identification strategies. We start with a *baseline* model that uses the vector of variables {*COM*, *FFR*, *P*, *Y*, *MMR*, *M*}. We then proceed to discuss the extended models, with variables those from the baseline model plus one additional variable. These additional variables are either the real exchange rate *ER* (or more precisely,

[8] See Hamilton (1994), p. 323-324 for details.

[9] For the same reason, we do not consider cointegration analysis.

one of the exchange rate measures $REER_{Arg}$ or $REER_{USA\setminus Arg}$), or the sovereign spread *JPM*.[10] Reporting the results from the baseline model first and then extending the baseline model is done to facilitate comparison and serves as a robustness check. We include *ER* and *JPM* separately for two reasons. First, including both variables together would increase the dimension of $\mathbf{y}$ to eight and thus consume precious degrees of freedom and make the estimates less precise. Second, both *ER* and *JPM* may react to similar information (e.g., the response to the Brazilian *real* depreciation), which could make the estimates less precise. On those grounds, including *ER* and *JPM* separately seems both reasonable and desirable. This gives that the variables included in each of the models, denoted $\mathbf{y}_{Baseline}$, $\mathbf{y}_{ER}$ and $\mathbf{y}_{JPM}$ are as follows:

$$\mathbf{y}_{Baseline} = \begin{bmatrix} COM \\ FFR \\ P \\ Y \\ MMR \\ M \end{bmatrix} \qquad \mathbf{y}_{\mathbf{ER}} = \begin{bmatrix} COM \\ FFR \\ P \\ Y \\ MMR \\ M \\ ER \end{bmatrix} \qquad \mathbf{y}_{\mathbf{JPM}} = \begin{bmatrix} COM \\ FFR \\ P \\ Y \\ MMR \\ M \\ JPM \end{bmatrix}$$

Next we look at the restrictions on $\mathbf{B_0}$ for each of the three specifications. For the *baseline* model, the identification restrictions on $\mathbf{B_0}$ are summarized in the following relation between the structural-form and reduced-form disturbances:

$$Baseline: \quad \begin{bmatrix} \varepsilon_{COM} \\ \varepsilon_{FFR} \\ \varepsilon_{P} \\ \varepsilon_{Y} \\ \varepsilon_{MS} \\ \varepsilon_{MD} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ * & 1 & 0 & 0 & 0 & 0 \\ * & 0 & 1 & * & 0 & 0 \\ * & 0 & 0 & 1 & 0 & 0 \\ 0 & * & 0 & 0 & 1 & * \\ 0 & 0 & * & * & * & 1 \end{bmatrix} \cdot \begin{bmatrix} u_{COM} \\ u_{FFR} \\ u_{P} \\ u_{Y} \\ u_{MMR} \\ u_{M} \end{bmatrix}$$

The ε_i are the structural-form disturbances for the commodity index, the Federal Funds Rate, prices, output, money supply and money demand respectively. The u_i are the reduced-form disturbances of the variables, and the nonzero elements of the matrix $\mathbf{B_0}$ are denoted by '*'. We now describe each of the equations in more detail. The first line is that of the commodity price index *(COM)*, which we take as contemporaneously exogenous to Argentina. The

[10] Adding variables one by one to a baseline model is sometimes called the 'marginal method'.

following line is the Federal Funds Rate *(FFR)* equation. The U.S. monetary authorities do not react contemporaneously to any of the Argentine domestic variables. However, we do allow within-the-month reactions to shocks to *COM*, based on the argument that variation in such an index may contain information about future inflation and therefore may help to solve or to reduce the 'prize puzzle'. The third and fourth equations describe equilibrium in the market for goods. Within the month, prices adjust to internationally determined commodity prices (capturing inflation expectations and/or a simple mark-up rule for the cost of commodities) and to output. Output reacts sluggishly to money market variables or prices, but is allowed to adjust within the month to shocks to *COM*. Next, equations five and six describe money market equilibrium. Because of the currency board arrangement and open borders for capital flows, the central bank does not have the power to set interest rates on its own. Instead, in the money supply equation *MMR* adjusts 'passively' to changes in U.S. monetary policy *FFR* and to shocks to the monetary base *M*. The money demand equation, on the other hand, is fairly conventional. Money demand responds contemporaneously to prices, output and domestic interest rates.

Next, we discuss the identification strategies for the models that include *ER* and *JPM*, in addition to the variables from the baseline specification. Essentially, the extended models are augmented versions of the baseline model. For the models with *ER* (with $REER_{Arg}$ and $REER_{USA\backslash Arg}$) and with *JPM*, the identification restrictions on $\mathbf{B_0}$ are summarized as follows:

ER, JPM:
$$\begin{bmatrix} \varepsilon_{COM} \\ \varepsilon_{FFR} \\ \varepsilon_{P} \\ \varepsilon_{Y} \\ \varepsilon_{MS} \\ \varepsilon_{MD} \\ \varepsilon_{ER}, \varepsilon_{JPM} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ * & 1 & 0 & 0 & 0 & 0 & 0 \\ * & 0 & 1 & * & 0 & 0 & 0 \\ * & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & * & 0 & 0 & 1 & * & 0 \\ 0 & 0 & * & * & * & 1 & 0 \\ * & * & * & * & * & * & 1 \end{bmatrix} \cdot \begin{bmatrix} u_{COM} \\ u_{FFR} \\ u_{P} \\ u_{Y} \\ u_{MMR} \\ u_{M} \\ u_{ER}, u_{JPM} \end{bmatrix}$$

The coefficients ε_{ER} and u_{ER} (ε_{JPM} and u_{JPM}) are the structural-form and reduced-form innovations of *ER* (*JPM*); all other symbols are the same as in the baseline model. For both *ER* and *JPM*, we impose the restrictions that neither variable affects any other variable contemporaneously, but all variables are allowed to affect *ER* and *JPM* within the period. In both cases, the additional equation can be thought of as the outcome of an international arbitrage argument.

This completes the discussion of the VAR methodology and of the identification restrictions of the empirical model. In the next section we discuss the results of our estimations.

4. Empirical Results

4.a. Preliminaries

Before we discuss our findings, we ask what a textbook Mundell-Fleming-Dornbusch style framework would predict about the direction of the major variables in response to shocks. We have in mind the case of a small economy with a commitment to a hard peg and no barriers to capital flows. Also, because of the time span of our data, our time horizon is that of the short-term to the medium-term. First, what are the likely effects of a contractionary U.S. monetary policy shock? After a positive shock to *FRR*, we would not expect *Y* or *P* to increase. The more synchronized U.S./Argentine business cycle movements and the stronger the trade links with the U.S. block are, the more likely it is that output will contract. *P* may react with a lag, and may even go up if the Federal Reserve does not anticipate future inflation much ahead of time. Ultimately, however, we would expect prices to fall in response to a U.S. monetary policy contraction. Also, if there is a liquidity effect then we may reasonably expect *MMR* to rise and *M* to fall (due to higher opportunity cost). Once inflation expectations adjust, the money market rate should stop overshooting and return to normal levels. Next, we consider the likely effects of a shock to *JPM*, the sovereign risk premium. The consequences of such a shock are ambiguous and depend crucially on the origins of the premium increase. If the increase in *JPM* reflects mainly news from other countries and there is little or no contagion, then a flight-to-quality argument might lead to a increased attractiveness of Argentine financial assets. Under such circumstances, it is possible to see an increase in *M*, and neutral or even expansionary effects on *Y*. If, on the other hand, an increase in *JPM* comes in part from a reevaluation of Argentine risk in response to worsening fiscal balance and deteriorating debt outlook, or if it comes from external developments coupled with contagion, then we expect the increase in *JPM* to have contractionary effects. In the latter case, one would expect *M* and *Y* to fall, and *MMR* to increase to reflect the higher risk premium. Third, we ask what the likely effects are of an increase in international commodity prices *COM*. If we interpret such an increase as a proxy for higher future inflation, then we would expect *MMR* and *P* to rise, and *Y* and *M* to fall in response. On the other hand, the rise in international commodity prices may reflect good news for Argentine commodities exporters, in which case the price increase may well be expansionary. Fourth and finally, we consider shocks to the real exchange rate $REER_{Arg}$. In response to a real exchange rate appreciation, it is reasonable to expect *Y* and *MMR* to fall at first, followed by a gradual return to long run equilibrium values. The extent to which *MMR* falls may help dampen the output contraction. We distinguish between the transmission of shocks that are come from changes in the U.S. real effective exchange rate ($REER_{USA\setminus Arg}$), and those that are due to Argentina's main trading partners ($REER_{Arg-USA}$). Under a hard peg regime, the domestic interest rate *MMR* ought to be tied to U.S. rates. In that case it is likely that *MMR* will fall by more in response to a dollar appreciation (when U.S. rates come down as well) than it would following a currency depreciation of one of Argentina's major trading partners. If the drop in *MMR* is large enough, this may dampen or even outweigh the output contraction from the loss of international competitiveness. On the other hand, if the exchange rate appreciation comes from non-dollar sources and *MMR* does not react strongly, then it is more likely that output will be lost. Next, we report and discuss the estimation results of the various specifications.

4.b. Estimation Results from the Baseline Model

We estimate the baseline model and the extended models with the measures of the real effective exchange rate ($REER_{Arg}$ and $REER_{USA\backslash Arg}$) and with *JPM* using monthly observations over 1993:01-2001:02. In each of the estimations we used six lags.[11] The impulse responses are reported in Figures 2-5, and the variance decompositions are presented in Tables 3-6.[12] In the figures, each row contains the decomposition or impulse response of a single variable to the corresponding shocks in the column. For the non-interest variables, the impulse responses are the percentage deviations from an underlying path. The confidence bands around the impulse responses are the 16-84 percentiles of a Bayesian simulation procedure with 5,000 draws, taking into account the overidentification of the model (see Sims and Zha (1999) and RATS (2002) for details). The results of the overidentification tests are reported in Table 2.

[Insert Table 2 here]

Based on the test statistics, the identification restrictions are not rejected at the usual degrees of confidence (for the specification with *JPM*, the restrictions are rejected at 10 percent confidence, but not at 5 percent). Also, when we compare the baseline model (Figure 2) to the extended versions (Figures 3-5) that include the real exchange rates and the sovereign risk premium, we find that the results of the extended models are quite robust to the inclusion of the extra variable. We now discuss the findings of the *Baseline* specification in greater detail.

The results of the baseline specification are summarized in Figure 2 and Table 3. Beginning with shocks to *COM*, we find that these affect prices and money with a lag of a few months. In particular, such shocks increase prices (though quantitatively the effects are very small) and they reduce the monetary base. Output appears to be declining somewhat within the year, but the effect is not statistically significant. Based on the variance decompositions, shocks to *COM* explain about 10 percent of the variation in prices, money and interest rates (over a 24 month horizon), but very little of output (three percent or less). These results seem consistent

---

[11] The lag exclusion tests typically indicate that three lags would be sufficient. Although a full set of at least twelve lags might be desirable with monthly data, our choice of using six lags is in line with other work and is strikes a balance with the length of the data set.

[12] Most of the estimated coefficients of the contemporaneous effects have rather large standard errors. The confidence bands in the impulse responses are reasonably narrow, giving us confidence that the large standard errors on individual coefficients is most likely due to collinearity.

with the idea that changes in international commodity prices may serve as a proxy for future inflation. The overall reaction of industrial production may be muted perhaps because improvements in the prices for exporters of commodities offset the adverse supply effects from higher future inflation.

Going to the second column in Figure 2, we find the responses of the domestic variables to changes in the stance of U.S. monetary policy, as measured by the Federal Funds Rate. A first observation is that contractionary U.S. monetary policy action affects money and interest rates in the short run. That is, interest rates rise quickly and up to five months after the shock, and the monetary base falls. It takes about one year for the money market to recover, after which the monetary base continues to rise. The latter response may be due in part to the reaction of the domestic price level to the monetary policy shock. After an initial rise in the price level, prices contract significantly after about one year. The initial rise in prices may qualify as a 'price puzzle', but may also come from other sources such as an imperfect alignment of the Argentine and U.S. business cycle. The variance decompositions of prices and money confirm the anchor role of U.S. monetary policy, especially over the longer-term horizon. Over a 24-month horizon, variation in *FFR* explains 14.1 and 21.7 percent of variation in prices and money respectively, rising to 23.6 and 27.6 percent over 30 months. In fact, *FFR* is the single dominant factor in explaining variation in those two variables. Also interesting is that only 10-14 percent of variation in *MMR* is explained by variation in *FFR*. However, most surprisingly perhaps, we find that output does not react significantly to shocks to U.S. monetary policy; the point estimates of the impulses show even a slight (and statistically insignificant) increase in industrial output following a *FFR* contraction. The variance decompositions lead to a similar finding that U.S. monetary policy is not a major source of business cycle variation in Argentina, with variation in *FFR* explaining only 7-9 percent of output variation over the short-term and medium term.

Before we move on to discuss the responses of the domestic economy to exchange rate and sovereign interest spread shocks, we note some other interesting findings from Figure 2 and Table 3. First, in response to shocks to prices, the impulse responses show that output increases and money falls significantly. Both output and prices increase in response to a money demand shock (increasing *M*), with the price effect longer-lived. Also, in response to a domestic money supply shock (increasing *MMR*), money falls significantly. Finally, we note the importance of variation in the monetary base in explaining output variation, especially in the short run. For the very short run (six months), money explains more than 20 percent of output variation, and over a 30 month period this is still 15.4 percent. This completes our description of the findings of the baseline model. Next, we discuss the results of the extended models.

[Insert Figure 2 and Table 3 here]

4.b. Estimation Results from the Extended Models

We now discuss our findings for the models that include the variables *ER* (that is: $REER_{Arg}$ and $REER_{US\backslash Arg}$) and *JPM* in addition to those variables from the baseline model. The estimated impulse responses are reported in Figures 3-5 and the corresponding variance decompositions are shown in Tables 4-6. The final column of Figure 3 shows the impulse responses of the domestic variables to a shock (appreciation) of Argentina's real effective exchange rate. We find that in response to such a shock, prices fall significantly over the 30 month horizon and output fall gradually (though the latter is not statistically significant). The appreciation also leads to a short-lived drop in interest rates and to a gradual increase in the monetary base. By and large, these are short-run effects that can be expected from such an appreciation. We also find that real exchange rate variability explains between 16.5 percent and 23.5 percent of variation in prices, but that its role in explaining the other domestic variables is fairly limited. For example, less than 10 percent of output variation is due to variation in the real exchange rate (see Table 4, final column). Note also that the role of *FFR* in the variance decompositions increases, at least for the monetary variables. How important is the variation in the U.S. component, $REER_{US\backslash Arg}$ in explaining Argentine fluctuations? To answer this question, we turn to Figure 4 and Table 5. Based on the variance decompositions alone, we must conclude the role of variation in $REER_{US\backslash Arg}$ is quite limited. For example, less than 1.3 percent of the variation in prices can be attributed to $REER_{US\backslash Arg}$. The variance decomposition of output also attributes a rather small role to this component (a maximum of 10.6 percent, for an 18 month horizon). We reach similar findings when we look at the impulse responses (last column of Figure 4). In fact, an appreciation in $REER_{US\backslash Arg}$ does not seem to lead to a slowdown in output.

Finally, Figure 5 and Table 6 summarize the results of the estimation with *JPM* as extra variable. Again, the role of the extra variable is borne out in the final column. Two points are noteworthy. First, we find that output contracts significantly and for a prolonged period in response to an increase in the sovereign risk premium. In fact, based on the variance decompositions, *JPM* explains up to 25.8 percent of output variation over a one-year horizon, and more than 22 percent over the medium term (30 months). Secondly, we find that the monetary base responds significantly and for a prolonged period to shocks in *JPM*. However, U.S. monetary policy remains a dominant factor in explaining the variation in the monetary base.

[Insert Figures 3-5 and Tables 4-6 here]

5. Further Discussion and Conclusions

This paper took up the question: How are shocks transmitted in Argentina during its currency board experiment of the 1990s? To answer this question, we estimated several VAR models with quite standard identification restrictions and obtained the variance decompositions and impulse responses of prices, output, interest rates and money. By and large, we found that shocks to commodity prices, U.S. monetary policy, the real exchange rate and the sovereign risk premium are transmitted into the Argentine economy. However, not all domestic variables are affected in the same way. We found that (1) prices react with a lag, but the quantitative impact is small, (2) the monetary base is affected by all types of shocks, (3) the money market interest rate appears to be affected by shocks in the very short run, but overall the effects are quite noisy, and (4) output is affected by money market shocks and by shocks to the sovereign risk premium. How do we interpret our findings?

First, our results indicate that U.S. monetary policy transmission occurred through nominal variables (*M*, *P*, *MMR*). However, the real effects of the monetary policy transmission are rather weak. More concretely, we do not find evidence that U.S. monetary policy actions played a prominent role in explaining Argentine business cycle movements in the 1990s. This is evident by the absence of any significant output response to innovations in U.S. monetary policy conditions. Although our results are in line with other studies that found rather weak international transmission of monetary policy actions, our prior was that this type of transmission would be stronger in the case of Argentina's currency board regime.

Second, we do not find evidence that the appreciation of the U.S. real exchange rate ($REER_{USA\backslash Arg}$) *in itself* affected the country adversely in any statistically significant way. Does this mean that we can conclude then that the currency board did not play a role in Argentina's stagnation towards the final years of the currency board regime? Not necessarily. First, even if there is no direct evidence that the U.S. appreciation hurt the real sector in Argentina, this does not imply that pegging to the dollar was the optimal choice to make. A fix to other currencies or a floating regime might have yielded better results. Second, and related to the first point, the currency board regime implies a constraint on the monetary base as well as on the exchange rate. We found that the monetary base reacted significantly to various types of shocks, and thus the currency board arrangement may have affected the economy through the monetary base rather than through the exchange rate channel. Third and finally, it might be that the VAR methodology and its focus on policy *shocks* is not ideal approach to analyze the effects of the gradual (or trend) appreciation in the U.S. exchange rate. Also, it could be argued that $REER_{Arg}$ became overvalued early on and remained above any sustainable level throughout the period, mainly because Argentina inflation was reduced only gradually over the first two years of the currency board period. With these observations in mind, however, our findings that $REER_{USA\backslash Arg}$ does not explain much of output variation provides little direct support for the hypothesis that the appreciating dollar was a main factor behind Argentina's stagnation. That the country does not exactly qualify as a 'small *open*' economy may have played a role in this (the ratio of imports plus exports over GDP is about 20 percent on average over 1991-2001).

Third, our empirical evidence shows that shocks to the sovereign risk spread affects both output and the money market. That is, we found that shocks to this index led to significant drops in output and the monetary base. As mentioned before, we see *JPM* as a proxy for the public financing constraint. More precisely, some of the variation in *JPM* may reflect at least in part shifts in investors' risk assessment of the ability of the government to continue to service its debt (and, by extension, the viability of the currency board regime itself). It is interesting to note that its effect is picked up by *industrial production*, for lack of more broadly defined output indicators available on a monthly basis. If a rise in the sovereign risk premium affected private financing constraints in the non-industrial sector as well, then the effects of the changing risk assessment of the sustainability of government finances on the domestic economy could have been more widespread.

Finally, we have the following suggestion for further research. Our findings indicate that the currency board regime allowed shocks to affect the monetary base but that, typically, neither money market interest rates nor output (industrial production, at least) seemed affected much by those shocks. Granted, interest rates pick up in the short run following shocks to either *FFR* or *JPM*, but much of its variation remains to be explained. This money market interest rate 'puzzle' begs the question about the interaction of the monetary base with more broad measures of money and credit, and also what the role the financial sector may play in explaining this result. Indeed, the degree to which shocks to the monetary base ultimately affect the economy may be determined in part by the presence of some financial accelerator mechanism or a bank lending channel. Also, the regulatory framework or the adjustment of the financial sector itself to the currency board (e.g. via increased presence of foreign banks, or by establishing credit lines), may have helped to 'absorb' shocks to the money market. Because such institutional arrangements and the design of the financial sector are factors in the ultimate success of a currency board regime, a closer look inside the financial sector itself may be justified.

REFERENCES

BERNANKE,Ben (1986). "Alternative explanations of the money-income correlation", Carnegie-Rochester Series on Public Policy, 25, p. 49-99.

BERNANKE, Ben and Alan BLINDER (1992). "The federal funds rate and the channels of monetary transmission", The American Economic Review, 82, p. 901-921.

DE LA TORRE, Augusto, Eduardo LEVY YEYATI and Sergio SCHMUKLER (2003). "Living and dying with hard pegs: The rise and fall of Argentina's currency board", Working Paper, 30 p.

EICHENBAUM, Martin and Charles EVANS (1995). "Some empirical evidence on the effects of shocks to monetary policy on exchange rates", The Quarterly Journal of Economics, November, p. 975-1009.

HAMILTON, James (1994). "Time series analysis", Princeton University Press, 799 p.

HAUSMAN, Ricardo and Andrés VELASCO (2002). "Hard money's soft underbelly: Understanding the Argentine crisis", Working Paper, 43 p.

KIM, Soyoung (2001). "International transmission of U.S. monetary policy shocks" Evidence from VAR's", Journal of Monetary Economics, 48, p. 339-372.

KIM, Soyoung and Nouriel ROUBINI (2000). "Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach", Journal of Monetary Economics, 45, p. 561-586.

MUSSA, Michael (2002). "Argentina and the Fund: From triumph to tragedy", Institute of International Economics, 67 (July), 90 p.

PERRY, Guillermo and Luis SERVEN (2002). "The anatomy of a multiple crisis: Why was Argentina special and what can be learn from it", Working Paper, 66 p.

RATS (2002). "Monte Carlo Integration, Revisited", The RATSletter, 15 (2), p. 1

SIMS, Christopher (1986). "Are forecasting models useful for policy analysis?", Federal Reserve Bank of Minneapolis Quarterly Review, 10, p. 2-16.

SIMS, Christopher (1992). "Interpreting the macroeconomic time series facts. The effects of monetary policy", European Economic Review, 36, p. 975-1000.

SIMS, Christopher and Tao ZHA (1999). "Error bands for impulse responses", Econometrica, 67, p. 1113-1156.

APPENDIX. Tables and Figures

Table 1. Top Five Trading Partners for U.S.A. and Argentina, in percent

Trading Partner	United States	Argentina
1. Canada	20.2	0.9
2. Japan	12.2	3.0
3. Mexico	10.1	1.7
4. China	5.2	2.8
5. Germany	4.6	4.3
Total Share:	52.3	12.7
Trading Partner	United States	Argentina
1. Brazil	1.5	23.9
2. Chile	0.4	5.1
3. Italy	1.9	4.4
4. Germany	4.6	4.3
5. Spain	0.7	3.7
Total Share:	9.1	41.4

Average share of exports plus imports in overall trade, 1992-2001.
Source: Directions of Trade Statistics.

Table 2. Results From Overidentification Tests

Model	Test Statistic (D.o.f)	Significance Level
Baseline	7.4415 (6)	0.2819
Extended, $ER = REER_{Arg}$	4.2678 (6)	0.6405
Extended, $ER = REER_{Arg\backslash US}$	9.3488 (6)	0.1549
Extended, *JPM*	11.2771 (6)	0.0802

Table 3. Variance Decomposition of Baseline Model, in percent

Variance Decomposition of Prices (P)						
Months	COM	FFR	P	Y	MMR	M
6	1.4	7.0	71.5	7.3	0.0	12.7
12	4.2	6.5	52.2	14.8	0.6	21.7
18	9.1	6.2	41.7	16.5	0.9	25.6
24	10.7	14.1	36.2	14.4	0.9	23.7
30	10.8	23.6	30.7	14.2	0.8	20.0
Variance Decomposition of Output (Y)						
Months	COM	FFR	P	Y	MMR	M
6	1.5	8.5	2.2	65.1	1.4	21.3
12	2.1	8.2	3.2	66.1	1.9	18.4
18	2.4	7.8	7.4	63.7	2.2	16.6
24	2.4	7.6	10.4	60.8	3.1	15.7
30	3.0	7.6	11.3	59.2	3.5	15.4
Variance Decomposition of Money Market Rate (MMR)						
Months	COM	FFR	P	Y	MMR	M
6	2.6	10.6	7.8	2.9	63.3	12.8
12	9.7	10.5	11.2	4.6	53.1	10.8
18	9.7	11.9	12.4	4.4	51.2	10.4
24	10.4	12.9	12.1	4.4	50.0	10.2
30	11.1	13.1	12.0	4.6	49.2	10.1
Variance Decomposition of Money (M)						
Months	COM	FFR	P	Y	MMR	M
6	4.0	7.7	12.7	12.9	15.2	47.4
12	7.6	10.0	10.2	19.9	18.4	33.8
18	11.8	11.5	9.1	26.4	14.7	26.6
24	10.1	21.7	9.6	26.3	12.0	20.3
30	8.6	27.6	10.7	24.8	11.2	17.2

Table 4. Variance Decomposition of Model $REER_{Arg}$, in percent

Variance Decomposition of Prices (P)							
Months	COM	FFR	P	Y	MMR	M	ER
6	4.4	22.4	31.8	7.1	7.5	10.3	16.5
12	3.7	18.9	17.2	13.8	6.8	16.2	23.5
18	5.2	14.3	11.9	17.9	9.1	19.5	22.1
24	5.5	21.7	9.5	15.4	9.3	17.5	21.0
30	5.5	31.3	7.8	13.5	7.9	14.4	19.7
Variance Decomposition of Output (Y)							
Months	COM	FFR	P	Y	MMR	M	ER
6	1.5	7.1	1.7	64.9	5.9	17.4	1.5
12	2.4	7.3	2.5	64.8	6.5	15.1	1.4
18	2.6	8.1	3.2	63.9	6.0	14.0	2.2
24	2.5	9.1	3.3	60.4	5.6	13.2	5.9
30	2.8	8.9	3.2	57.4	5.4	12.9	9.5
Variance Decomposition of Money Market Rate (MMR)							
Months	COM	FFR	P	Y	MMR	M	ER
6	2.6	15.2	3.6	3.2	58.0	13.4	4.0
12	10.5	15.4	4.8	4.3	49.5	11.3	4.2
18	10.0	18.1	4.6	4.2	46.7	11.0	5.4
24	10.2	20.0	4.4	4.2	44.6	10.7	5.9
30	10.5	20.1	4.3	4.2	44.0	10.8	6.2
Variance Decomposition of Money (M)							
Months	COM	FFR	P	Y	MMR	M	ER
6	5.0	15.7	2.6	13.9	24.3	34.9	3.7
12	6.4	19.0	1.8	18.2	20.9	22.6	11.2
18	8.4	20.3	1.9	20.8	17.3	19.0	12.2
24	6.9	35.4	1.9	18.6	13.6	14.4	9.1
30	5.5	45.0	1.9	16.9	11.3	11.5	8.0

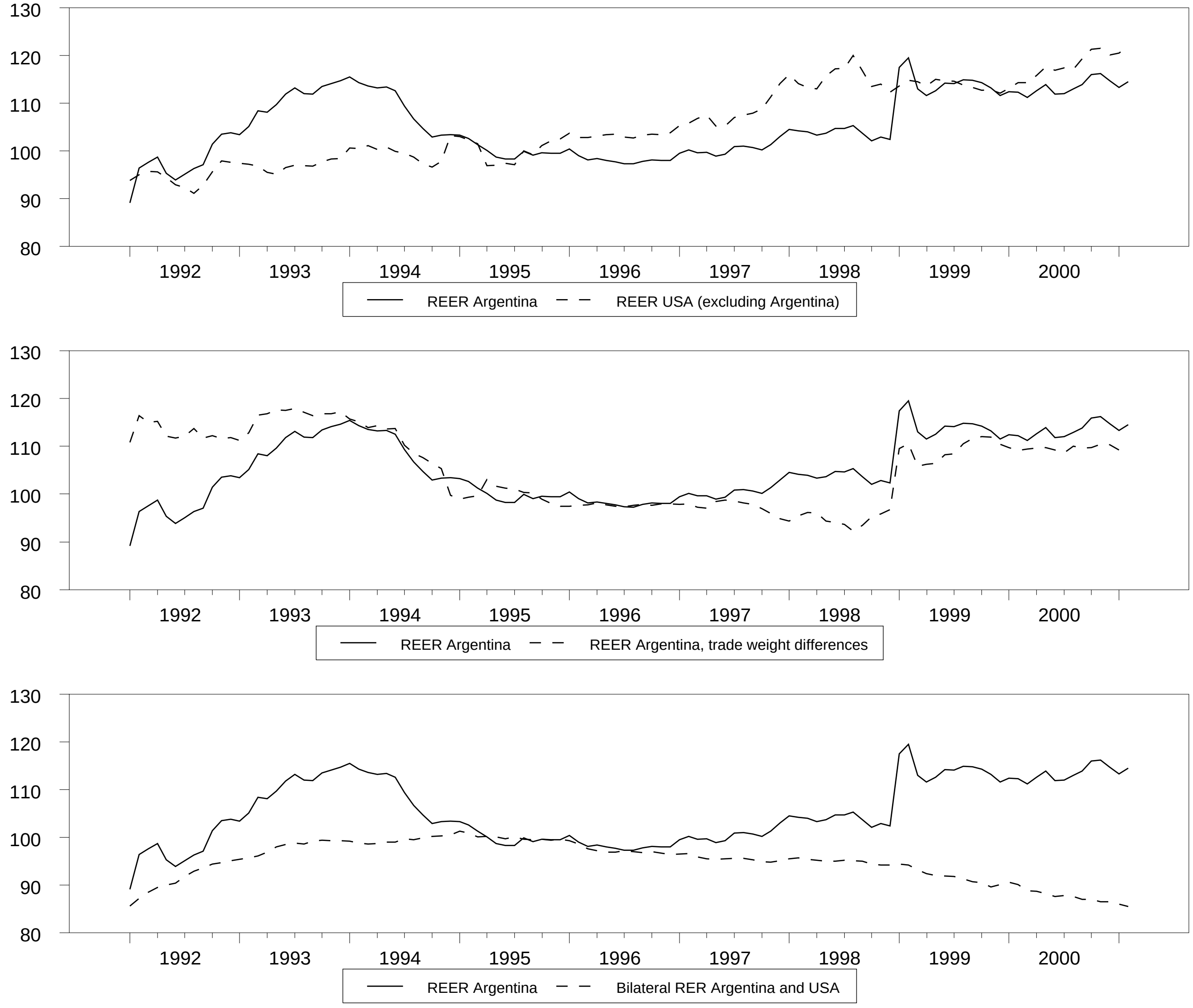
Table 5. Variance Decomposition of Model $REER_{US\backslash Arg}$, in percent

Variance Decomposition of Prices (P)							
Months	COM	FFR	P	Y	MMR	M	ER
6	1.0	9.4	73.0	5.7	2.6	7.8	0.6
12	6.3	7.9	55.5	8.5	5.2	16.1	0.5
18	12.6	7.4	45.5	7.2	10.5	16.3	0.5
24	13.5	12.7	40.2	7.1	11.1	14.6	0.7
30	12.9	17.3	36.7	8.5	10.2	13.2	1.3
Variance Decomposition of Output (Y)							
Months	COM	FFR	P	Y	MMR	M	ER
6	5.4	10.1	2.3	46.5	15.7	15.3	4.8
12	6.7	9.9	3.6	39.7	17.8	13.2	9.2
18	6.6	11.2	3.8	37.7	17.4	12.7	10.6
24	6.2	22.2	3.6	32.4	14.9	10.8	9.8
30	7.2	32.3	3.0	27.4	12.9	9.0	8.3
Variance Decomposition of Money Market Rate (MMR)							
Months	COM	FFR	P	Y	MMR	M	ER
6	1.8	12.0	4.6	2.0	52.0	22.7	4.9
12	10.3	13.1	6.0	2.8	44.6	18.7	4.6
18	10.3	14.9	6.4	2.9	42.8	18.0	4.6
24	11.1	18.3	6.1	2.9	40.2	17.0	4.4
30	11.9	18.9	6.0	2.9	39.4	16.6	4.4
Variance Decomposition of Money (M)							
Months	COM	FFR	P	Y	MMR	M	ER
6	6.1	9.3	5.9	2.3	57.1	15.1	4.2
12	6.4	13.6	9.4	2.2	52.2	10.8	5.4
18	8.9	14.0	10.0	3.3	45.1	9.5	9.2
24	6.7	28.5	9.1	5.3	32.8	7.2	10.4
30	5.4	45.9	6.9	6.0	22.3	4.9	8.5

Table 6. Variance Decomposition of Model *JPM*, in percent

Variance Decomposition of Prices (P)							
Months	COM	FFR	P	Y	MMR	M	JPM
6	1.9	11.7	66.8	7.3	0.2	11.8	0.4
12	4.5	8.8	57.2	9.2	1.3	17.5	1.5
18	7.8	9.8	49.7	7.8	1.5	19.4	4.0
24	8.3	15.8	44.8	7.6	1.7	17.9	3.8
30	8.3	18.9	40.4	9.4	1.6	16.2	5.2
Variance Decomposition of Output (Y)							
Months	COM	FFR	P	Y	MMR	M	JPM
6	2.6	5.4	6.1	60.0	1.2	15.5	9.2
12	4.0	5.2	5.2	44.8	3.4	11.7	25.8
18	4.1	4.8	7.3	45.4	3.3	10.9	24.3
24	3.8	5.3	11.3	42.8	3.8	10.1	22.9
30	4.4	5.2	12.5	41.3	4.6	9.7	22.4
Variance Decomposition of Money Market Rate (MMR)							
Months	COM	FFR	P	Y	MMR	M	JPM
6	2.8	12.3	7.2	1.4	58.6	14.3	3.4
12	11.1	10.6	9.0	4.0	48.5	11.9	4.9
18	10.6	12.1	10.6	4.2	45.9	11.1	5.4
24	11.5	12.6	10.5	4.1	44.8	11.0	5.5
30	12.3	12.5	10.4	4.3	44.1	10.9	5.5
Variance Decomposition of Money (M)							
Months	COM	FFR	P	Y	MMR	M	JPM
6	3.7	16.9	10.5	4.0	12.0	48.9	4.1
12	12.3	21.0	7.6	3.9	17.1	27.8	10.2
18	15.5	17.7	6.5	12.3	14.1	21.8	12.2
24	12.1	20.0	7.4	16.6	10.9	16.9	16.1
30	10.7	22.2	8.9	17.4	9.9	14.4	16.5

Figure 1. Real Effective Exchange Rate (REER) and Components (1995 = 100)



Source: International Financial Statistics, Directions of Trade Statistics, and Own Calculations

Figure 2. Impulse Response Functions, Baseline Model

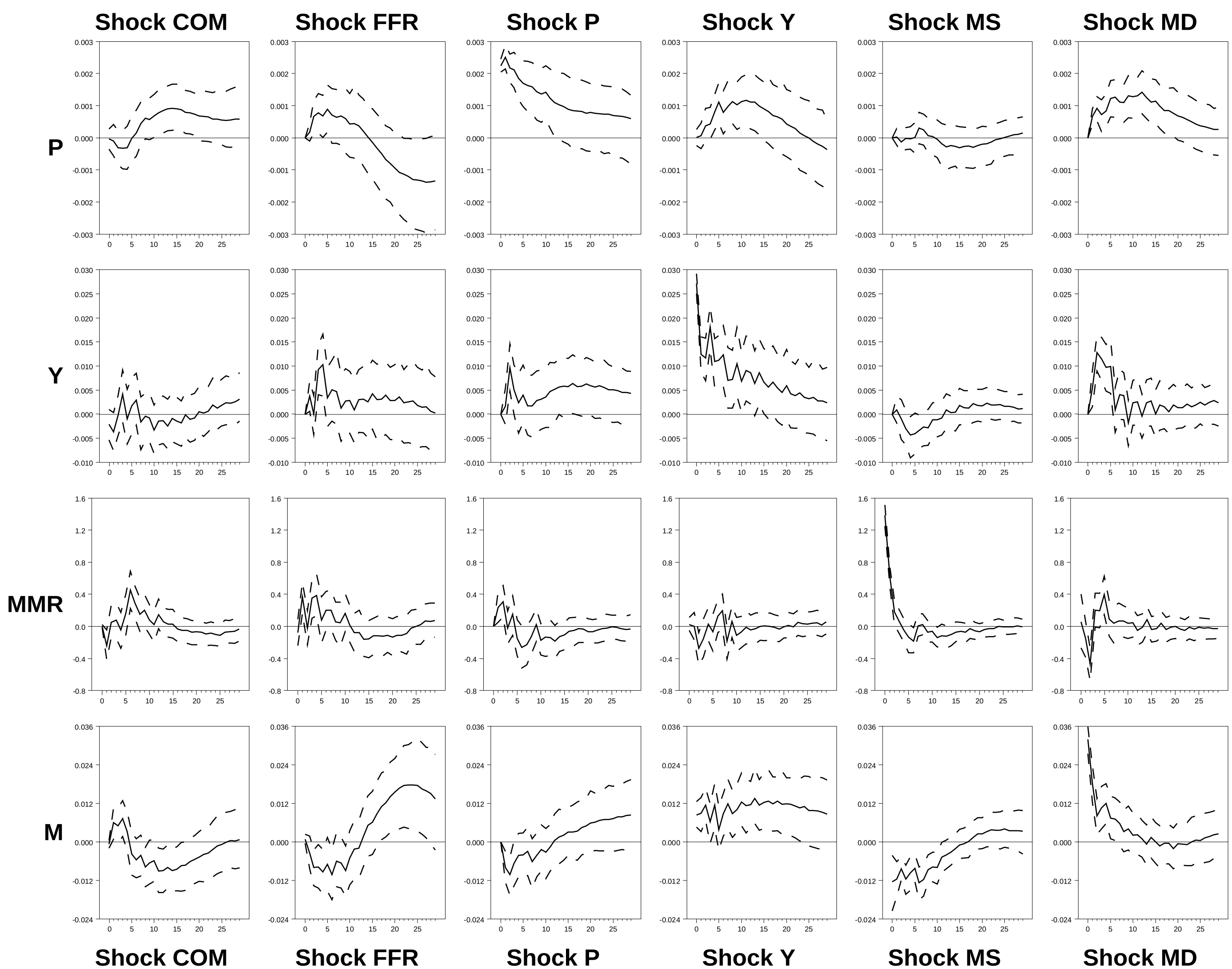


Figure 3. Impulse Response Functions, Extended Model (ER = REER_{Arg})

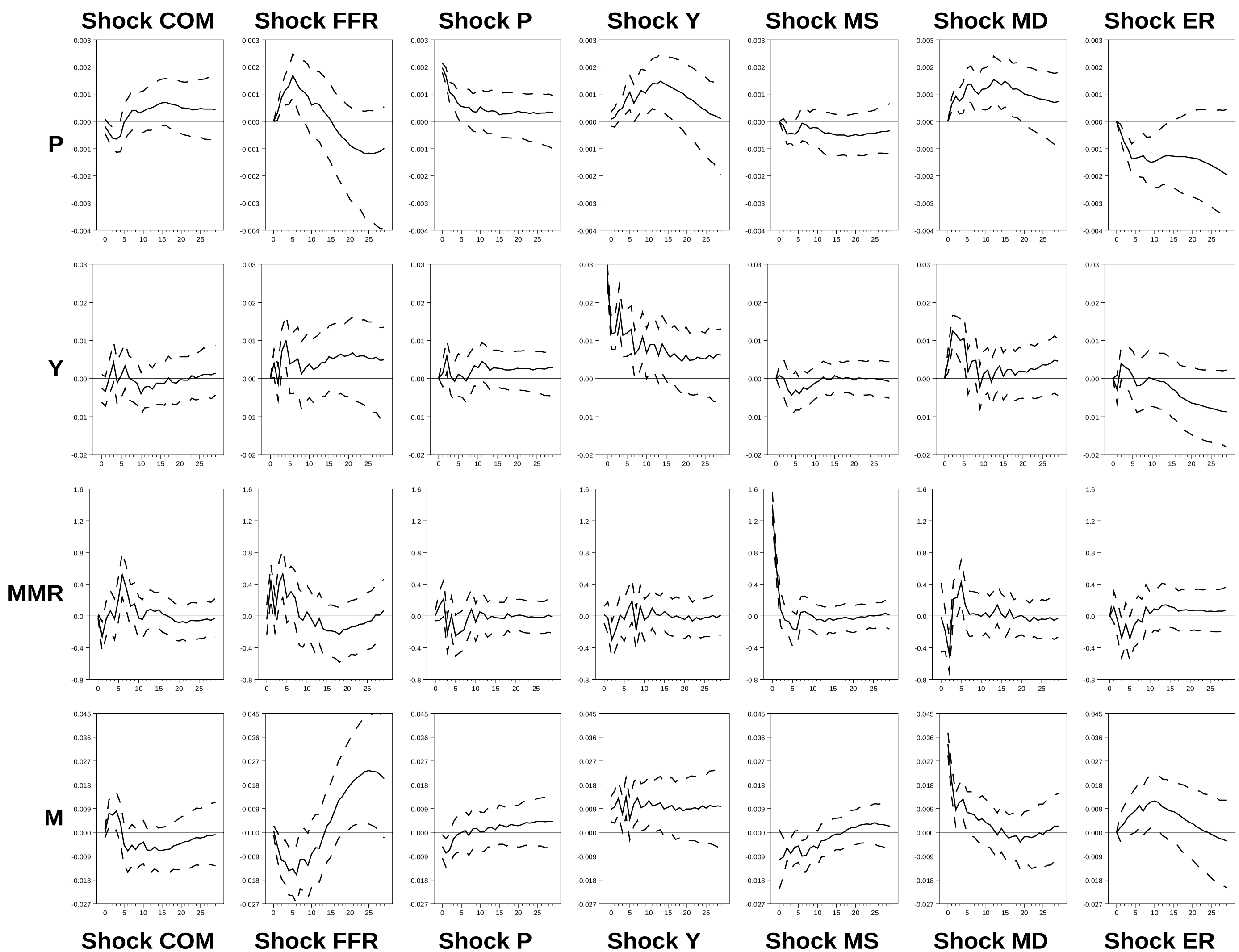


Figure 4. Impulse Response Functions, Extended Model (ER = $\text{REER}_{\text{US}\backslash\text{Arg}}$)

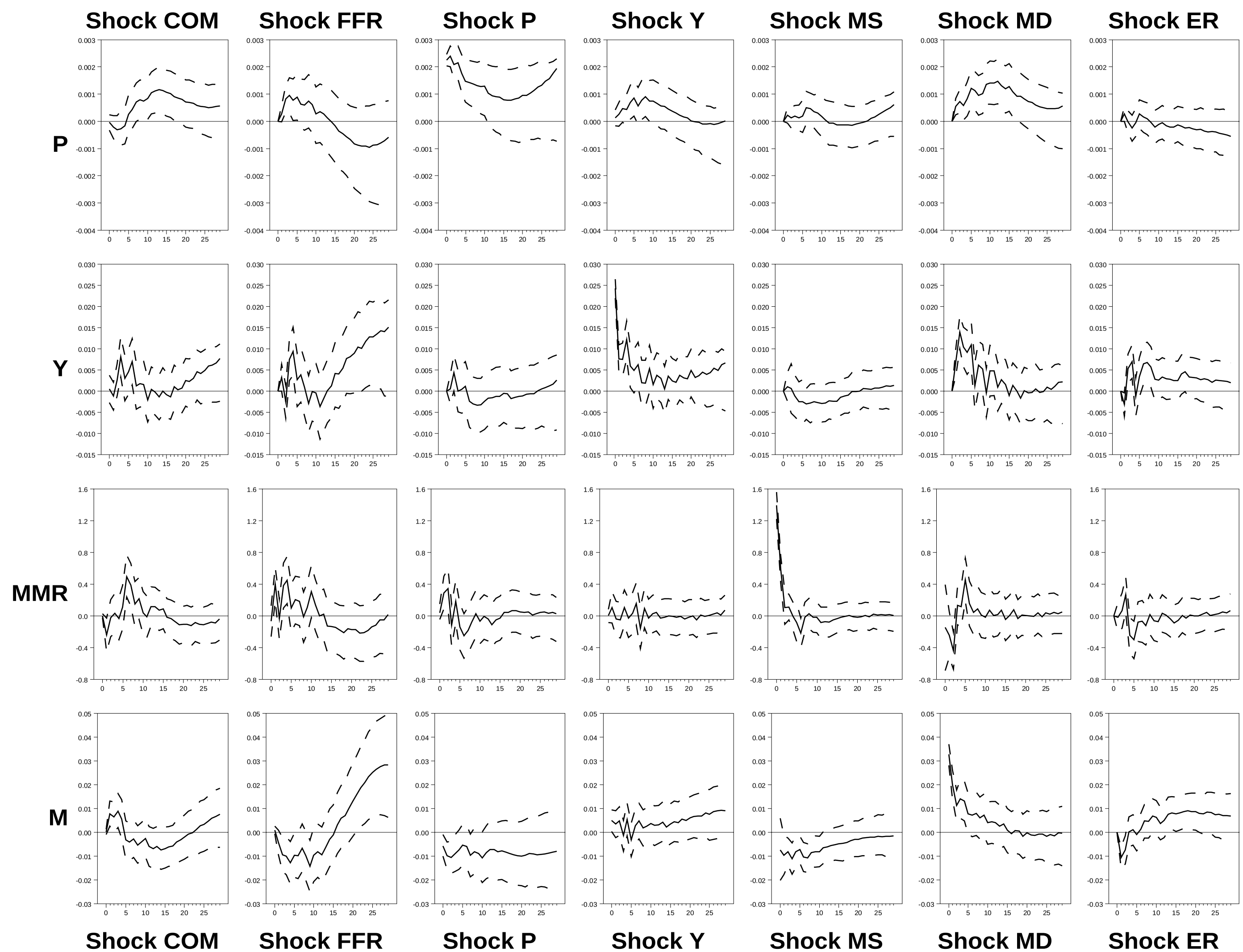


Figure 5. Impulse Response Functions, Extended Model (*JPM*)