

Financial shocks and macroeconomic policies during the Argentine crisis of 2001-2002

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Abstract

The objective of this paper is analyse the determinants of the Argentine crisis of 2001-2002. In particular we analyse the role of macroeconomic policies during the crisis. The crisis coincided with a sudden stop of capital flows. We use a VAR model to better understand the shocks and mechanisms by which the crisis propagated throughout the economy. We find evidence that Argentine crisis was the consequence of an external financial shock, expressed by the increase in sovereign spread, amplified by local vulnerabilities. Fiscal policy, that faced financial restrictions, was tightened and the economy suffered additional contractionary fiscal shocks. The recession was exacerbated by a real exchange rate shock, that was appreciated. This result is the consequence of the rigid fixed exchange rate used by Argentina and the lack of coordination inside the Mercosur agreement where Brazil devaluate while Argentina not. Our analysis suggests the convenience of generate an institutional framework that allows a flexible use of fiscal and exchange rate policies to confront with adverse external shocks.

Keywords: crisis, Argentina, country risk, fixed exchange rates, procyclical fiscal policy.

JEL classification: E32, F33, F34, F41

1 Introduction

The Argentine crisis is a paradigmatic case of an emerging country crisis originated in a sudden stop of capital flows. The understanding of the effects of fiscal and exchange

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rate policies during the crisis can be a reference for other emerging countries that have to deal with similar adverse shocks.

After the capital flows reversal, that followed the Russian default of August 1998, Argentina decided to follow a contractionary fiscal policy and maintained its rigid fixed exchange rate regime (the "Convertibility"). The important financial restriction suffered by the public sector and the idea that a tight fiscal policy could restore confidence and foster economic activity, motivated the adoption of this type of fiscal behaviour. The adverse balance sheet effects associated to a devaluation in a dollarized economy, promoted the maintenance of the Convertibility. Argentina suffered a long lasting recession that finally conducted to a deep crisis in 2001-2002, when Argentina abandoned the peg and defaulted in its public debt.

The central goal of this paper is to study the role played by macroeconomic policies during the Argentine crisis and its implications for the optimal macroeconomic policy of an emerging country that faces an external financial shock. Specifically, we focus on the following questions. 1) What was the role played by the fiscal policy during the Argentine crisis? Is there any evidence about an expansive effect on GDP of a contractionary fiscal policy via a credibility improvement? 2) What is the role of the real exchange rate in the adjustment process of a dollarized economy that has to deal with a sudden stop? 3) What was the role of the Convertibility in the Argentine crisis? Or more in general, does the exchange rate regime matter for the adjustment process of a dollarized economy after a sudden stop?

During and after the Argentine crisis there has been an important debate, both at academic and policy level, about the role played by macroeconomic policies during the crisis. However, there has been little formal empirical analysis about the issue, which is the aim of this work.

In this paper we try to contribute with new evidence to this debate. We perform VAR analysis to see the dynamic interactions between financial shocks and macroeconomic policies in the Argentine case. We analyse the different shocks suffered by Argentina and their role in the development of the crisis. In the case of some relevant shocks (the Brazilian devaluation and the Convertibility collapse and default of beginning of 2002) we use the dummy variable approach. By this way we are able to see the specific effects of these special events.

The paper is organized as follows. Section 2 briefly presents some facts about the Argentine crisis. Section 3 reviews some related literature. Section 4 discusses several methodological issues, including the choice of variables and the identification of shocks. Section 5 presents the main results of the paper. Section 6 analyses how sensitive are the results to changes in some methodological options. Section 7 concludes.

2 The Argentine crisis

Argentina enjoyed during 1990's a significant growth process with a decreasing inflation. Public debt to GDP ratio decreased during the first half of the decade and remained at low levels during the second half. Argentina participated with Uruguay and Brazil in the Mercosur integration process¹ and had in operation stabilisation plans based on an exchange rate peg. The financial system of Argentina and Uruguay

¹The Mercosur was established on 26 March 1991 with the signature of the Asunción Treaty by the Presidents of Argentina, Brazil, Paraguay and Uruguay.

was in a great extent dollarized, and also the majority of the public debt was issued in foreign currency.

The financial problems of East Asia and Russia led to a reversal of capital flows to emerging countries and to Mercosur countries in particular (specially after the devaluation and default of Russia on August 1998). At the beginning of 1999, Brazil abandoned its exchange rate peg while Argentina and Uruguay opted for maintaining their stabilisation plans. A long lasting recession started in Argentina and Uruguay, that finally led to an important economic crisis and to problems with the management of public debt.

In a companion paper, Mourelle (2009), we provide a more detailed analysis about the crisis of 2001-2002 in Argentina and Uruguay. In that paper we characterize the crisis as the result of an adverse external shock in a vulnerable environment. The vulnerable environment was given by a perverse combination of unsustainable fiscal policies, fixed exchange rate and a great de facto dollarization.

The two processes also exhibited some differences. Uruguay had a more flexible exchange rate peg that allowed a more gradual adjustment of the real exchange rate.² Rating agencies gave investment grade status to the Uruguayan public debt. The public debt of Uruguay was issued at low interest rates, which facilitated its restructuring after the devaluation. On the contrary the Argentine exchange rate peg (the "Convertibility") was very rigid.³ The Argentine public debt was issued at high interest rates during the recession which implied a strong restriction for fiscal policy. Argentina finally defaulted on its public debt and the following tortuous restructuring process implied unprecedented investor losses ("haircuts", in financial jargon).

In Table 1 we can see the growth rate of different Argentine variables during the period 1995-2007. During the second half of 1998 recession started in Argentina (seasonal adjusted GDP decreased 0.6% with respect to the first half of 1998). The beginning of the recession was related to a reversal in capital flows to Mercosur countries, associated to the Russian devaluation and default of August 1998. As can be seen in Table 1, Argentine EMBI⁴ was 4,4% during the first half of 1998 but jumped to 7,6% during the second half. In the same period the Brazilian EMBI was doubled (it jumped from 5,3% to 10,7%).

At the beginning of 1999 Brazil abandoned the "Real Plan" and its currency suffered a great depreciation. The Argentine bilateral real exchange rate with respect to Brazil suffered during 1999 an important appreciation (it decreased 32,1%)⁵ and also the Argentine Effective real exchange rate was appreciated (-5,3%). Sovereign spread remained at high levels after the Russian default as it is shown in Table 1. The financial restrictions and the idea that a tight fiscal policy could restore confidence motivated the development of a contractionary fiscal policy. As can be seen in Table 1, government expenditure decreased 0,6% in 1999 and then significantly decreased from 2000 until the second half of 2002 when it started to increase again.

²Uruguay had in operation a crawling band from 1991 to 2002. At the beginning of the program, the exchange rate of the Uruguayan peso in relation with the US\$ was allowed to fluctuate within a band of 7%, the band was devaluated at 2,5% per month.

³The Convertibility was in operation from 1991 to 2001, and consisted in a currency board. The exchange rate was fixed by law in 1 Argentine peso equal 1 US\$.

⁴EMBI ("Emerging market bond index"): corresponds to the sovereign spread (% over US government risk free bonds that have to pay public bonds).

⁵Giving the way we define real exchange rate, a decrease implies an appreciation.

Table 1: Argentina: GDP, EMBI, RER, government expenditure and other financial variables

GDP ^a	EMBI ^b Argentina	EMBI ^b Brazil	RER ^c Brazil	RER ^c Effective	RER ^c US	Gov ^d Exp	Reserves ^e	Deposits ^f	Credits ^g	Unrecoverable ^h credits	
1995	-2,8	12,2	11,2	13,8	2,6	-0,5	4,7	-23,9	-8,5	1,5	-
1996	5,5	7,2	6,9	5,5	-3,2	2,7	4,6	41,9	20,5	3,2	-
1997	8,1	3,9	4,5	-0,8	-4,6	1,8	6,9	33,1	23,2	13,8	61,2
1998: ⁱ	2,2	4,4	5,3	-2,2	-2,5	-0,1	-3,5	9,3	11,0	7,7	15,1
1998:II^j	-0,6	7,6	10,7	-4,1	0,9	0,7	2,6	9,1	7,3	5,8	5,2
1999	-3,4	7,2	10,4	-32,1	-5,3	3,4	-0,6	7,6	11,0	5,2	16,7
2000	-0,8	6,7	7,3	7,1	2,0	4,3	-9,3	1,4	4,5	-4,8	26,0
2001	-4,4	15,6	8,9	-15,4	-4,7	3,9	-4,5	-20,1	-6,1	-9,4	22,8
2002:I^j	-7,5	50,0	9,1	149,4	88,6	133,6	-18,3	59,9	-23,9	-23,6	-13,4
2002:II ^j	0,8	64,7	18,2	-13,7	0,1	14,1	8,7	-3,6	-19,5	-17,1	-4,3
2003-2005 ^j	9,0	44,9	5,9	4,4	-2,1	-7,7	21,0	10,6	12,4	-6,4	1,1
2006-2007 ^j	8,6	3,3	2,1	9,2	1,9	-3,2	15,7	29,4	7,8	19,0	-17,2
Correlation with GDP	1,00	-0,37	-0,72	0,60	0,35	0,65	0,89	0,84	0,65	-0,08	-0,02

^a Growth rate (in %) of seasonal adjusted real GDP.

^b EMBI ("Emerging market bond index"): corresponds to the sovereign spread (% over US government risk free bonds that have to pay public bonds).

^c Growth rate (in %) of real exchange rate.

^d Growth rate (in %) of real government expenditure (sum of wages, purchase of goods and services and investment).

^e Growth rate (in %) of real foreign exchange reserves in the Central Bank.

^f Growth rate (in %) of total real deposits in the financial system.

^g Growth rate (in %) of total real credits given by the banking system to the private sector.

^h Growth rate (in %) of total real unrecoverable credits in the banking system.

ⁱ Growth rate with respect to previous midyear (except for EMBI where entries are average EMBI value during the considered period).

^j Average annual growth rate (except for EMBI where entries are average EMBI value during the considered period).

The level of credits, given by the banking system to the private sector, decreased permanently from 2000 onwards contributing to the decrease in the level of activity. The unrecoverable credits in the banking system increased during the recession, and were also increasing before the GDP started to decline. This last fact could be a signal of solvency problems before the recession which were later aggravated and derived in the banking crisis of 2001.

The final stage of the crisis was characterized by a triple run (against banking deposits, public debt and currency). As can be seen in Table 1, deposits in the financial system decreased during 2001 and also EMBI experimented a great increase in 2001. These financial problems affected the level of reserves that declined 20,1% during 2001. During 2001 Argentine peso was again appreciated with respect to Brazil.⁶

Finally, on January 2002 the peso was allowed to float. In parallel the government decided a default on the public debt⁷ and the foreign currency deposits and credits in the banking sector were compulsory transformed into pesos.⁸ The period also included a general institutional turmoil with several provisional and short-lived governments taking office one after another.

3 Literature review

In this section we briefly review the literature about the Argentine crisis. We will focus on the role played by the macroeconomic policies according to the literature.

Mussa (2002) claims that the main problem was the excessively expansionary fiscal policy during the second half of the 90's. The idea that the crisis had fiscal roots was shared by policy makers and multilateral financial institutions. A contractionary fiscal policy could have an expansive effect on GDP, according to this view, via the drop in insolvency fears, see also on this IMF (2003).

This literature also denied the possibility of escape from the recession via currency depreciation, basically due to the dollarization of public and private debt. Nevertheless, in IMF (2003) it is also present the idea that an early abandonment of the Convertibility including a debt restructuring could have been a solution.

Calvo and Talvi (2005) claim that a contractionary fiscal policy can have an expansive effect via credibility improvement only if the crisis is localized. That could be the case if for example the origin of the sudden stop is the lack of confidence in the fiscal prudence of new authorities. In this case if these new authorities follow a tight fiscal policy, economic confidence can be restored which could improve the access of private sector to capital markets. This kind of policy has more probability of success if it is complemented with multilateral financial support or if coincides with a period of capital inflows towards emerging markets. In the case of a systemic crisis (e.g. a

⁶The EMBI Brazil also increased at that moment. Given the Brazilian floating regime the Brazilian currency suffered a new important depreciation that implied a new real appreciation for the Argentine peso.

⁷After a negotiation process defaulted debt was exchanged for new debt on May 2005. The swap included a very important haircut. After the swap sovereign spread fell dramatically as can be seen in Figure 1

⁸Deposits were transformed into peso deposits at an exchange rate of 1,4 pesos per dollar (also their maturity was extended) and credits were transformed into peso credits at a rate of 1 peso per dollar. The exchange rate of 1 peso per dollar, in force during the "Convertibility" period, dramatically changed in the following months reaching almost 4 pesos per dollar in June 2002.

"systemic sudden stop") a tight fiscal policy can aggravate the crisis. They stress on the impact on emerging markets of the sudden stop of capital flows after the Russian crisis. They state that the ability of an emerging economy to deal with a sudden stop is related with the degree of openness and with the degree of liability dollarization. Given that the degree of openness of Argentina was relatively low, the change in the real exchange rate required to adjust the current account was very large. With a dollarized economy this is likely to induce important financial problems. Argentina economy was vulnerable due to this two problems with independence of the exchange rate regime. These arguments are also developed on Calvo et al. (2003).

Hausmann and Velasco (2002) emphasize the role played by the decrease in the international investors willingness to lend to emerging countries and the drop in expected exports in 1998. These events led to a high country risk, lower capital inflows, less investment, and a lower GDP which in turns led to a decrease in the ability to borrow. The underlying theoretical arguments are developed in Céspedes et al. (2004).

Ortiz et al. (2007) analyse the role of fiscal and monetary policies in several "systemic sudden stop" (SSS) episodes (including Argentina after the Russia crisis). They show evidence that tighter fiscal and monetary policies during SSS are associated with higher drops in output. They conclude that the IMF's view that fiscal and monetary policies has to be tightened to restore credibility is questioned by the empirical evidence.

Powell (2002) uses a monthly VAR from the period 1997-2001 in Argentina. He includes as variables: EMBI, Deposits, fiscal revenues, imports and political risk. He shows that a shock that increases imports (closely related to output) decreases sovereign spread. Powell (2002) interprets this result as evidence that the main problem was not a concern about the current account sustainability (in this case an increase of imports would have increased sovereign spread). This result could also be interpreted as evidence that GDP performance is very important for the country risk (and for the capital flows). We will see more evidence on this on Section 5.1

Our work seeks to provide new evidence about the Argentine crisis. By using VAR analysis this paper makes a quantitative evaluation about the role played by financial shocks and macroeconomic policies during the development of the crisis.

4 Methodological considerations

4.1 Choice of variables

As come out in our analysis in Section 2, the initial shock was the capital flows reversal (exemplified by the EMBI increase in the second half of 1998) and the Brazilian devaluation at the beginning of 1999. The final stage of the crisis is related to a general deterioration of financial conditions (e.g. EMBI increase in 2001).

In order to analyse the interactions between sovereign risk, fiscal policy and exchange rate regime during the crisis, we decided to include in our benchmark specification 4 variables: sovereign risk (EMBI Argentina), government expenditure, GDP and Effective real exchange rate. These four variables seems to have played an important role in the development of the crisis. Sovereign risk is closely connected with the public debt dynamics and with the origins of the crisis.⁹ It can also be considered

⁹It will also help us to see if a contractionary fiscal policy can increase GDP through a drop in

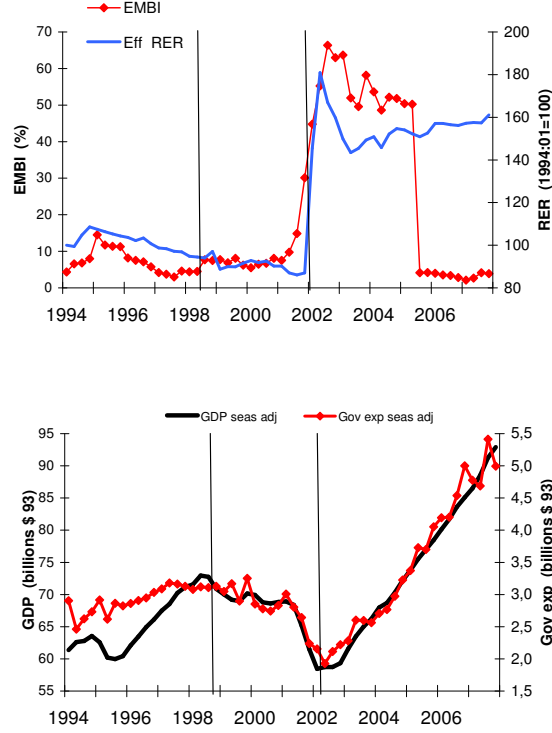


Figure 1: Argentina: Benchmark variables

a general measure of financial distress. Public expenditure is a classical variable to analyse fiscal policy. The evolution of the Effective real exchange rate is linked with the exchange rate regime and with the dynamics of the crisis.

In Section 6.2 we comment the results of our analysis using other definitions of the benchmark variables.

We will use quarterly data from the period 1994:I to 2007:IV. The reduced sample is given by data restrictions, as it happens with many works about emerging economies. In particular the information about EMBI elaborated by JP Morgan starts in 1994. In Figure 1 we show the evolution of the four variables during the analysed period. As we have already commented, EMBI is expressed in % over US government risk free bonds. Public expenditure is defined as the sum of wages, purchase of goods and services and investment ("discretionary" expenditure)¹⁰, cash basis. Public expenditure and GDP are expressed in billions of \$ 1993. Effective real exchange rate is an index with value 100 in 1994:I. All variables enter in logs in the VAR except EMBI.

The sources of data are described in Appendix A.

4.2 Identification of shocks

In order to identify the shocks we will use a Cholesky decomposition. In the case of the sovereign spread shock we assume that changes in the other variables do not have a contemporaneous effect on the country risk.

country risk.

¹⁰As we will discuss in Section 6.2 we also run the VAR with other definitions of public expenditure, without observing changes in the results

Information about EMBI is available on a daily basis. An unexpected increase of EMBI undoubtedly implies problems to finance public spending and to roll-over existing public debt. This could lead, in the same quarter, to the decision to decrease or postpone some public expenditures or directly to the impossibility of execute some public expenses due to a liquidity restriction.

A capital flows reversal, expressed in an EMBI increase, can also affect available financing for private consumption and investment and conduct to postpone some private expenses. That seems to be the case of the capital flows reversal provoked by the Russian default during the third quarter of 1998. At that moment the EMBI increase was accompanied by a contemporaneously decrease of consumption and investment in Argentina.

An unexpected increase of EMBI can affect contemporaneously Effective real exchange rate. This could certainly be the case during the flexible exchange rate period. During the Convertibility, an EMBI movement can affect the Argentine internal prices (through the changes in aggregate demand that we commented) or the exchange rate with trading partners, others than the US. For example, the capital flows reversal of 1998:III, was accompanied with the depreciation of the currencies of some Argentine trading partners.

A change in other variables can affect sovereign spread by changing the investors evaluation about fiscal sustainability, but information about the other variables is available with lags. Moreover, the interpretation of the effect of a temporary change in the other variables in fiscal sustainability could not be straightforward. For example, a decrease in government expenditure could improve fiscal sustainability, but if it is made in the middle of a recession it could aggravate the recession, which could also affect public sector solvency, a point that we will discuss later. A similar point can be made about a change in the Effective real exchange rate due to changes in the exchange rate with respect to trading partners, other than US. This type of change is not clear what kind of effect will have on fiscal sustainability. A change in the exchange rate with respect to the US can have an effect in fiscal sustainability, given the dollarization of the public debt. However we do not have this kind of shocks during the Convertibility, and the end of the Convertibility and associated devaluation is identified by another approach (dummy variable approach). During the period that debt was on default it is not clear what effect could have on EMBI an exchange rate movement. After the swap, debt was less dollarized, and there was no relevant movement of the exchange rate with respect to the US.

EMBI reflects the willingness of foreign investors to hold Argentine public debt. From this point of view, EMBI is the more external of the considered variables, what could also justify its inclusion as the most exogenous variable.^{11,12}

In order to identify the fiscal shock we assume that changes in the other domestic variables do not have a contemporaneous effect on government expenditure. Given that public expenditure is one of the components of aggregate demand, an unexpected increase of public spending implies a contemporaneous increase of GDP by this way. This direct effect can be amplified or diminished by the indirect effects on the other de-

¹¹In Section 6.2 we analyse the results using composite EMBI or Brazilian EMBI, instead of Argentine EMBI. In this case the interpretation of EMBI as an external financial shock is more clear.

¹²We also run the VAR assuming that EMBI can be affected contemporaneously by the other variables. The results under this specification are discussed in Section 6.3.

mand components. Public expenditure relies more on non-tradable goods and services and so can affect real exchange rate contemporaneously. On the contrary, changes in the other domestic variables are less likely to have a contemporaneous effect in the majority of the government expenditure components, which is specially true for the type of expenditure that we are considering in our benchmark model ("discretionary" expenditure).

Finally we assume that real exchange rate shocks have no contemporaneous effect on GDP. A change in the Effective real exchange rate due to changes in the exchange rate with respect to trading partners, others than US, can affect output via changes in net exports. However, the change in net exports may need some time to materialize. The majority of the Effective real exchange rate shocks during Convertibility are of these type. An Effective real exchange rate shock induced by a change in the exchange rate with respect to the US, can also have, in a dollarized economy, balance sheet effects added to the competitiveness ones. Balance sheet effects could affect GDP more rapidly. However, as we have already discussed, the more important real exchange rate shock of this type (the end of the Convertibility) is identified by another approach. During the flexible exchange rate period, the dollarization was drastically reduced.¹³ Moreover, after the adjustment associated to the end of peg, there did not seem to have occurred relevant shocks to the peso-dollar relationship.

The option of ordering first EMBI, then GDP and then real exchange rate is also used in the literature, as for example in Allegret and Sand-Zantman (2009) in a work that tries to evaluate the convenience of a monetary union in Latin America using VAR analysis.¹⁴ The already commented work of Powell (2002) identify its VAR, used to analyse the Argentine crisis, assuming that EMBI is the most exogenous variable, while imports (a close proxy for output) is more endogenous.

The alternative of ordering government expenditure as the most exogenous domestic variable is widely used in the VAR literature on fiscal policy, as for example in Blanchard and Perotti (2002), Müller (2008) and Ravn et al. (2007). Rezk et al. (2006), analyse fiscal policy in Argentina using a VAR where public expenditure is assumed to be the most exogenous variable, while GDP is more endogenous (in their VAR there is no EMBI or real exchange rate).

This identification scheme can be implemented estimating the reduced form coefficients, and then computing the Cholesky factorization of the reduced form covariance matrix with the variables in the order that were presented at the beginning of Section 4.1.

We use a "narrative" or "Dummy variable" approach as a complementary approach to identify the effects of some important events. In particular we identify by this way the effects of the Brazilian devaluation. We also use this approach to identify the effects of the events of the beginning of 2002. As we commented, at that moment Convertibility was abandoned, default was declared, credits and deposits on the banking system were pesified, and there was a general institutional turmoil.

In Appendix E we describe briefly the dummy variable approach.

We use four impulse dummies. We include one dummy for the effects on the Argentine economy of the Mexican crisis of the beginning of 1995 (the "Tequila crisis"); this variable is always zero except in 1995:I. The second dummy that we include is a

¹³As we commented deposits and credits were compulsory pesified.

¹⁴Allegret and Sand-Zantman (2009) do not use government expenditure in their VAR.

dummy for the Brazilian devaluation of the beginning of 1999; this dummy is always zero and takes the value of one in 1999:I. The third dummy is a dummy for the end of the Convertibility and the default that takes place in Argentina at the beginning of 2002, the dummy takes the value of one in 2002:I and 2002:II and zero otherwise. Finally we include a dummy for the debt swap of 2005, the variable is always zero except on 2005:III when it takes the value of one. We add one lag to each dummy. The dummies for the "Brazilian devaluation" and for the "end of peg and default" will be used to identify the dynamic effects of these events, as we commented. The four dummies will also contribute to improve the performance of the residuals.

4.3 Trend specification and other issues

We test the stationarity of the variables using unit root tests. The results of these tests, shown in Appendix B, suggest non stationarity of the four variables. We also perform Johansen test to check possible cointegrating relations between the variables. We make the test with a specification that includes one lag, as it is suggested by AIC criteria.¹⁵

We also include seasonal dummies,¹⁶ and the four impulse dummies, with one lag added to each dummy, that we commented.¹⁷ We have a good behavior of residuals in this case.

As we can see in Table 5, shown in Appendix B we cannot reject the hypothesis that the cointegrating rank between our four variables is zero.¹⁸

We decide to use as benchmark a VAR where non stationarity is modelize as stochastic (stochastic trend model, "ST"). We take first differences of the variables. We include one lag for each endogenous variable, as it is suggested by AIC criteria.¹⁹ The AIC values for different VAR orders are shown in Appendix C. We also check the behaviour of our model using other VAR orders, but in these cases the behavior of residuals was worse, and the forecast performance of the model was diminished. In particular we check the behavior of the same VAR but with 4 lags, a benchmark that it is used in some papers. In this particular case, we also have a worse behaviour of the residuals and our benchmark model seems to be more efficient forecasting. In Appendix D we compare the forecast properties of our benchmark model with the same model but with 4 lags.²⁰ We include in our baseline specification the 4 dummies that we commented previously. We also add 1 lag to each dummy. We also include a constant and seasonal dummies.

We conduct a battery of formal tests to check the behavior of the residuals and the subsample stability of our model. According to these tests, the residuals seem to have a good performance in terms of whiteness and normality and they do not show

¹⁵Using other lag orders the behavior of the residuals is worse.

¹⁶We obtain the same results with seasonal adjusted data and without seasonal dummies.

¹⁷Impulse dummy variables do not affect the asymptotic properties of the test according to Lütkepohl (2005).

¹⁸In the results presented in Appendix B we assume a linear trend in the data. We also run the test assuming a quadratic trend without observing changes in the results.

¹⁹A VAR order of one is also used in related literature, as for example in Allegret and Sand-Zantman (2007) or in the already commented work of Powell (2002).

²⁰We also try using a specification that only includes the lag 4. In this case the behaviour of the residuals is worse and the impulse response functions are difficult to interpret, so we discard this option

evidence of ARCH behavior, as can be seen in Appendix C. No structural breaks are detected when doing recursive estimation and looking at the recursive Break-point Chow-test statistics at the 1% significance level.²¹ Inverse roots of the AR polynomial lie inside the unit circle, so our VAR satisfies the stability condition.

We also run other versions of the model (e.g. changing the definition of the variables or the dummies), as we will discuss in Section 6.

Recently, there have been many criticism of results that crucially depends on the method used to induce stationarity.²² In order to address this issue, as in Blanchard and Perotti (2002), we also run versions with deterministic trends ("DT"). In these cases variables enter in levels and we allow for a linear and a quadratic trend in the 4 variables.²³ We use as benchmark the ST specification because the residuals behavior and the stability performance was better. Furthermore the results are similar with both specifications as we will see in Section 6.3.

5 Results

In this Section we present the main results of the paper. In Section 5.1 we analyse the dynamic effects of an unexpected increase of each of the four endogenous variables. We also present the dynamic effects of the Brazilian devaluation of beginning of 1999 and of the end of the Convertibility and default of the beginning of 2002. In Section 5.2 we present the variance decomposition of the four variables according to our benchmark specification. In Section 5.3 we show the estimated shocks during the analysed period. We try to explain the crisis using these shocks, making special reference to the role of the macroeconomic policies during the crisis. Finally, in Section 5.4 we make some considerations about the timing of the end of peg.

5.1 Impulse response functions

In Sections 5.1.1 to 5.1.4 we discuss the impulse response functions of the four endogenous variables, where the shocks are identified with the general procedure described in Section 4.2. The effects of an unexpected increase of one standard deviation of each of the four variables that we are considering are shown in figures 2 and 3. We show the responses of the variables for the 8 quarters after the shock. The responses of the variables can be interpreted as percentage changes. The IRF are shown by solid lines and shaded area represents one standard error bounds, computed using Monte Carlo simulations, assuming normality by means of 500 repetitions.

In Sections 5.1.5 and 5.1.6 we discuss the dynamic effects of two important events related with the Argentine crisis (the Brazilian devaluation and the end of the Convertibility accompanied with the default). In these cases, as we commented, the shocks are identified with the dummy variable approach.

²¹In Section 6.1 we will comment on the stability of some key results if we run our model for the "Convertibility" period and for the "flexible exchange rate" period. We will see that the sign of the GDP responses to the different shocks seems to be the same in the two periods.

²²See for example the controversy between Gali (1999) and Christiano et al. (2003) about the effects of technology shocks.

²³We also run the DT model with an interaction term between the linear trend and the dummy "end of peg and default", instead of the quadratic trend. The results were similar to the ones reported in Section 6.3.

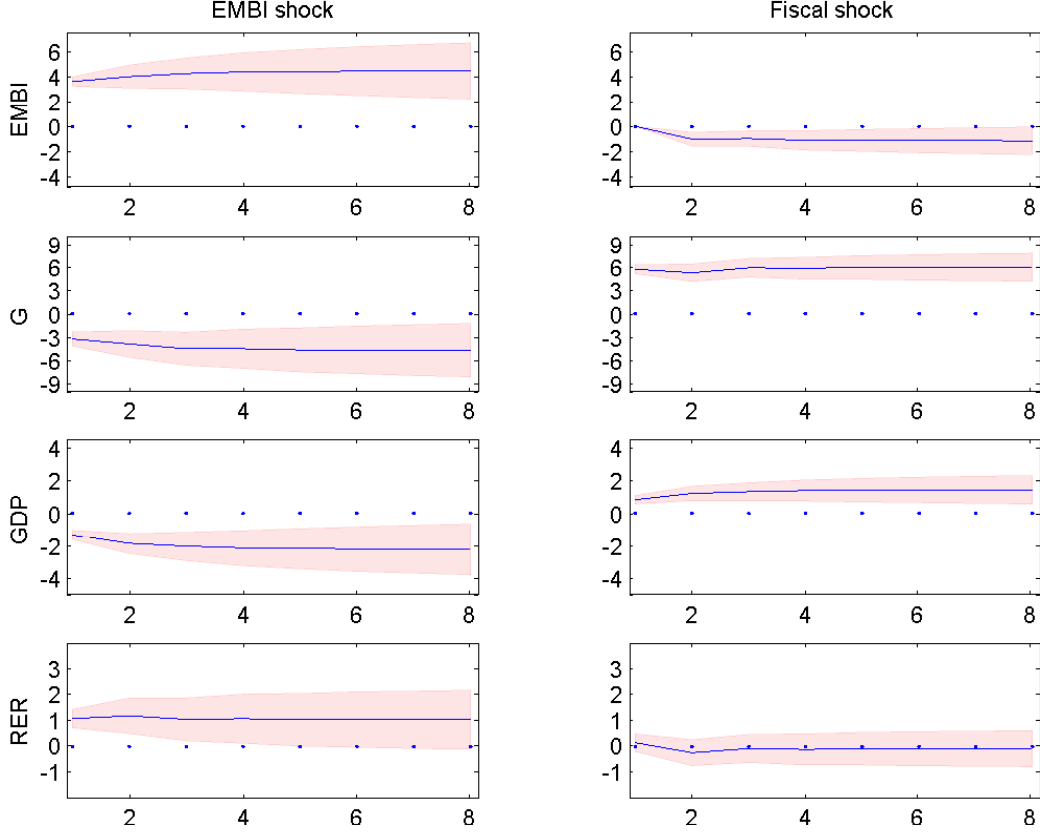


Figure 2: Effects of country risk premium and of a fiscal shock on benchmark variables

For visual convenience the impulse responses in Figures 2 to 5 have been accumulated to show the evolution of the levels of the variables over time.²⁴

5.1.1 Sovereign spread shock

A sovereign spread shock can affect aggregate demand through several channels. First, a shock that increases EMBI implies problems to finance public spending. Furthermore via increasing the real interest rate in the economy, it can reduce private consumption and investment.

The left panel of Figure 2 displays the effects of an unexpected increase of one standard deviation of EMBI. The initial shock implies that sovereign spread increases 3,6%,²⁵ and the final effect is an increase of 4,4%. This shock has a clear recessive effect; GDP declines significantly 1,3% in the first period, and the final effect is a decrease of more than 2%. Government expenditure also decreases 3,2% at the beginning and the final effect is -4,7%. Finally, Effective real exchange rate depreciates 1%.

²⁴Also by this way we facilitate the comparability with the results under DT presented in Section 6.3.

²⁵If for example before the shock US government bonds pay an interest of 3% and Argentine sovereign dollar bonds of the same maturity pay 7%, i.e. sovereign spread is 4%; the one SD unexpected increase of EMBI implies that sovereign spread becomes 7,6% and so Argentine bonds have to pay 10,6%. As we have commented this kind of shock can be interpreted as reflecting a "sudden stop" of capital inflows.

5.1.2 Fiscal shock

Given that public expenditure is one of the components of aggregate demand, an unexpected increase of public spending directly increases GDP by this way. This direct effect can be amplified or diminished by the indirect effects on the other demand components.²⁶

The right panel of Figure 2 shows the effects of a fiscal shock, i.e. a public expenditure increase of one standard deviation. Government spending increases close to 6%. This increase in government expenditure has an expansive effect over GDP that initially increases 0,8%. The maximum effect on GDP is reached in the fourth quarter (1,4%). Real exchange rate appreciates and EMBI decreases after the increase on government expenditure. The effects on these two variables seems to be less relevant, specially in the case of real exchange rate where the effect is statistically insignificant. The drop in EMBI seems to be related to the expansive effect on GDP of the fiscal shock. An increase in GDP decreases sovereign risk as we can see on Figure 3.

Our results are in contrast with the view that a fiscal adjustment could increase output in Argentina via a confidence shock. This kind of channel would imply that a government expenditure shock is followed by an EMBI movement in the same direction (a decrease in government expenditure would be followed by a decrease in EMBI or an increase in government spending would be followed by an increase in EMBI). However, we do not find evidence about this hypothesis. Our results can be interpreted using the distinction of Calvo and Talvi (2005) between "localized" and "systemic" sudden stop, that we commented in Section 3. The sudden stop suffered by Argentina in 1998 was not only due to a lack of confidence in the Argentine situation. As we have analyzed, the problem was related to the "systemic sudden stop" suffered by emerging countries after the Russian crisis, and so a contractionary fiscal policy is less likely to have an expansive effect on GDP via an improved credibility.²⁷

5.1.3 Real exchange rate shock

An unexpected real exchange rate depreciation can increase output via an improve in competitiveness that fosters net exports.²⁸ In a dollarized economy it can also have negative effects on the balance sheets of agents with debts in dollars.

An unexpected depreciation of the Effective real exchange rate has an expansive effect on GDP, according to the IRF of our VAR shown in the right panel of Figure 3. GDP increases 0,4% in the period after the shock (by identification the initial effect on

²⁶In the case of private consumption, for example, a keynesian model would predict an increase of private consumption after an increase in public expenditure, while a neoclassical model usually predicts the opposite. As we commented, a change in government expenditure could affect default expectations, and consequently real interest rate, private consumption and investment. In our case we run the VAR including as a fifth changing variable, private consumption, private investment, exports and imports. We observe that the four components increase after a fiscal shock.

²⁷A graphical example of the absence of this beneficial effect of a contractionary fiscal policy in the Argentine case is given by the results of the "zero deficit" policy. The same day that Minister Cavallo announced this policy (15/07/2001), that included a nominal cut on wages and pensions of 13%, EMBI rose from 1200 to 1600 basis points. To see different explanations about this striking fact, see Powell (2002) or Hausmann and Velasco (2002).

²⁸It can also have a negative effect on output via the price increase of imported inputs. The effects on output could also be different depending on the deviation of the actual real exchange rate from its equilibrium value.

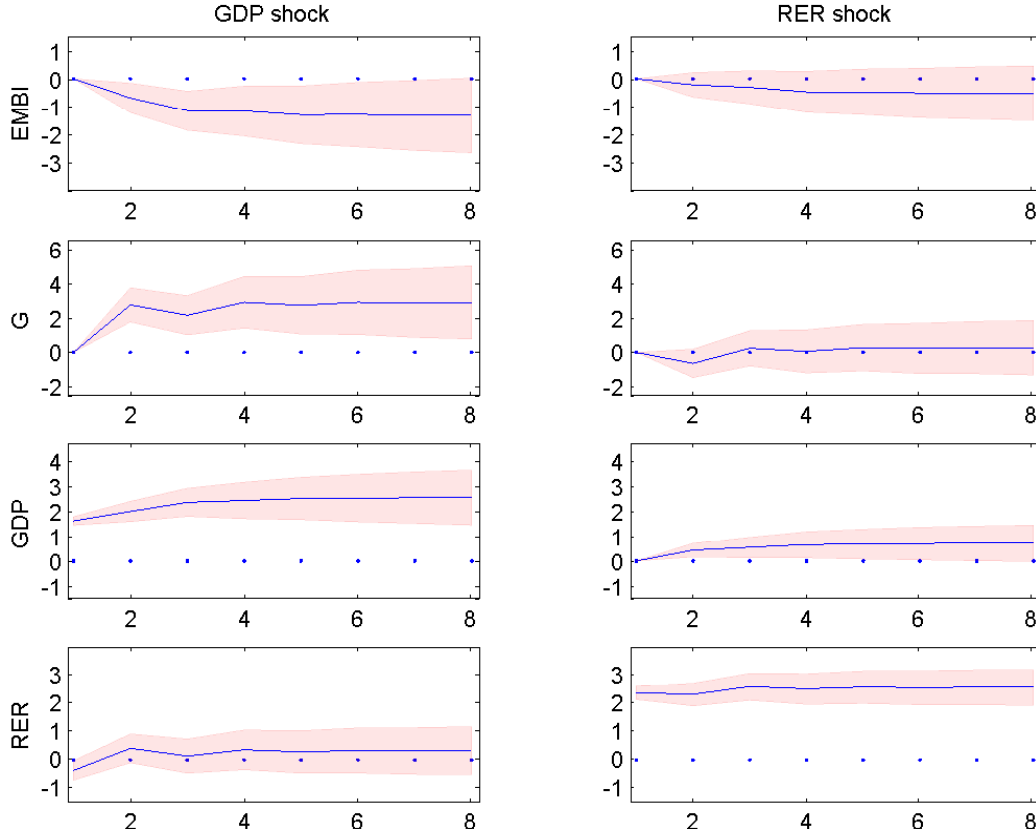


Figure 3: Effects of GDP and Effective RER shock on benchmark variables

GDP is zero), and the final effect is an increase of 0,7%. The shock itself represents a depreciation of real exchange rate of 2,4%. The effect of the real exchange rate shock on GDP does not seem to be very important. However, we are excluding from this analysis two important real exchange rate shocks, the brazilian devaluation, and the abandonment of the peg (made in conjunction with the default and other measures). The effect of these other shocks will be analysed in Sections 5.1.5 and 5.1.6. The minor GDP effects of this shock can also be the consequence of the simultaneous operation of different channels with contradictory effects on output.

This shock increases government expenditure (after an initial negative effect) and decreases sovereign spread. The effects over government expenditure and EMBI seems to be related to the expansive effect on GDP of this shock. However these effects on EMBI and government expenditure are non significant.

5.1.4 GDP shock

Finally, as we can see on the left panel of Figure 3, a GDP one SD shock (i.e., an unexpected increase of GDP of 1,6%) has a significant and persistent expansive effect on public spending that remains around 3% higher of its initial level during the two years. Sovereign spread progressively decreases after the shock and it is 1,3% lower after two years. These effects can be interpreted as evidence of procyclical fiscal policies and capital flows, a typical phenomenon of many emerging economies as it is documented by Kaminsky et al. (2004). For the Mercosur case Badagián and Cresta (2005) also find evidence of procyclical fiscal policy behaviour. As we have already commented our results are consistent with the evidence provided by Powell (2002). He

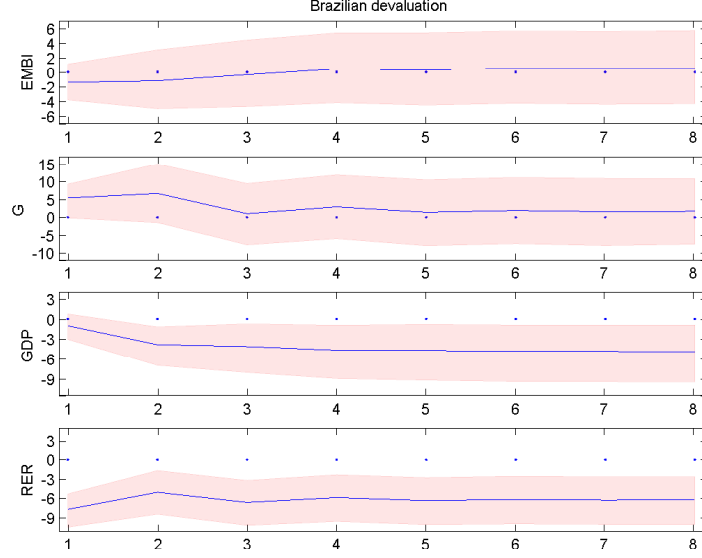


Figure 4: Responses of benchmark variables to a shock on Brazilian devaluation dummy

finds that a shock that increases imports (a close proxy for activity) decreases EMBI using Argentine data from the period 1997-2001.

Real exchange rate appreciates at the beginning and then depreciates not significantly after this shock.

5.1.5 Dynamic effects of the Brazilian devaluation

Figure 4 displays the dynamic effects of a unit shock to the Brazilian devaluation dummy.²⁹ The shock implies an initial appreciation of the real exchange rate of 7,6%, and the final effect is a real appreciation of 6%.

This shock has a recessive effect on GDP. The effect on output reaches a peak after 5 quarters, where GDP decreases 4,8%.

Although the signs are reversed with respect to Figure 3, the effects on output of this real exchange rate shock are very similar. Also as in the case of the real exchange rate shock of Figure 3 the effects on EMBI and government expenditure are not significant.³⁰

The occurrence of this shock was the consequence of the different response of Argentina and its main trading partner (Brazil) to the capital flows reversal of mid 1998. The maintenance of the Convertibility in Argentina combined with price rigidity prevented real exchange rate to adjust. On the contrary Brazil abandoned its Real Plan and the sharp adjustment of its exchange rate implied a new appreciation shock

²⁹In Figures 4 and 5 the IRF are shown by solid lines and shaded area represents 66% confidence bands computed using bootstrap by means of 500 repetitions. The procedure used to construct the confidence bands is the same used by Blanchard and Perotti (2002) and Perotti (2007) in the case of a dummy variable shock.

³⁰In Figure 3 the final effect of a depreciation of the RER is a decrease in EMBI and an increase in government expenditure. Here an appreciation of the RER finally increases EMBI (similar effect considering the sign change) and increases government expenditure (different effect considering that the shock has another sign). However, the final effects in these two variables are clearly not significant in Figures 3 and 4.

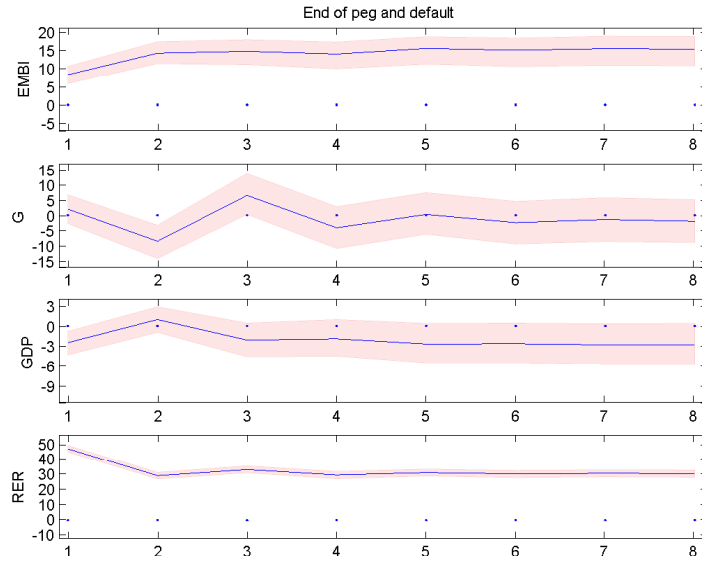


Figure 5: Responses of benchmark variables to a shock on "End of peg and default" dummy

for Argentina that aggravated the recession as we can see in Figure 4.

This shock calls our attention to the necessity of macroeconomic coordination inside a commercial agreement. The asymmetric response of trading partners to a symmetric shock can be a source of problems as it is analysed by De Grauwe (2003).

5.1.6 Dynamic effects of the end of peg and default

Figure 5 displays the dynamic effects of a unit shock to the "end of peg and default" dummy.

This dummy captures the great devaluation associated with the end of the Convertibility. The dummy also catches the effects of the default (that was declared at the same time as the abandonment of the peg) that implied a great increase in country risk and the exclusion from financial markets. At the same moment Argentina suffered the effects of the banking crisis, and the government took several radical measures at this respect (limitations to the disposal of deposits, together with the pesification of credits and deposits). The period also included a general institutional turmoil with several provisional and short-lived governments taking office one after another. All these effects may have played at the same time with different effects on GDP, so this shock is not clearly associated with one of the shocks that we studied in Section 5.1. In terms of our four variables VAR, this shock could be considered as a combination of a RER depreciation shock, with an EMBI shock and possibly a recessive GDP shock (related with the institutional instability and the banking crisis).

As we can see in Figure 5 this shock implies an impressive initial depreciation of the real exchange rate of 47%, that at the end becomes a real depreciation of 30%. The shock also implies an initial increase of EMBI of 8,3%, EMBI continues increasing and the increase is 15% after the fifth quarter.

These two shocks have an opposite effect on GDP according to our analysis of Section 5.1. As we have commented, during this period we had also other events that could have had some negative effects on GDP. As we can see on Figure 5, GDP

decreases 2,5% in the first period. This effect is reversed in the following period where output increases 1%. In the following periods the effect on GDP become negative. However, the effects from second period onwards are non significant.³¹

Government expenditure initially increases, then decreases, and continues oscillating in the following periods until the 6th quarter when the total effect becomes negative. With the exception of the effects on the second and on the third quarter, the other effects are non significant.

5.2 Variance decomposition

Table 2 shows the variance decomposition of the four variables according to our baseline specification.

As can be seen in the table, 35% of the error in forecasting GDP is due to the EMBI shock. Argentine economy seems to be very sensitive to external financial shocks. This result can be also found in the work of Allegret and Sand-Zantman (2009).

Fiscal policy seems to matter for GDP: 14% of the forecast error of GDP is explained by government expenditure.

Real exchange rate shocks seems less relevant to explain GDP (4% of GDP forecast error). In this result we have to take into account that we have included dummies for the main movements in the real exchange rate.

5.3 Estimated shocks: interpreting the crisis

The first four panels of Figure 6 show the estimated shocks, during the analysed period, of the four endogenous variables.³² The last two panels show the Brazilian devaluation dummy and the end of peg and default dummy. The role of these variables in the Argentine crisis is similar to the estimated shocks, so we show them together.

In the first four panels the vertical axis is scaled such that one unit is equal to one standard deviation (SD). A shock of 1 SD in one variable shown in Figure 6 has the effects on the levels of the 4 endogenous variables that is shown in Figures 2 and 3. For example an EMBI shock of 1 SD has the effect on the levels of 4 endogenous variables that is shown in the left pannel of Figure 2. A unit shock in one of the dummies has the effect in the level of the four endogenous variables shown in Figures 4 and 5.

We can see that in terms of shocks we can characterize the beginning of the process that conducts to the crisis as an EMBI shock. When the recession started, in the third quarter of 1998, there is a 0,8 standard deviation EMBI shock. This shock has a clear recessive effect on GDP, as we analysed in Section 5.1.1. At the same time we have an appreciation real exchange rate shock of -0,9 SD.³³

This original adverse shock was amplified by an even more important real exchange rate appreciation shock in the first quarter of 1999 (the Brazilian devaluation). This

³¹If we do not include the lag of this dummy, the effects on GDP of this shock have some changes. The only significant effect is in the first period (GDP decline) and on the second period the effect is positive as here. However, from the third period onwards the effect on GDP is positive. The stability behaviour of the VAR is better with the lag, so we use this specification as bechmark.

³²In Appendix F we explain how we compute the shocks.

³³The EMBI shock, as we already discussed, was a symmetric shock for Latin America economies, but Argentine exchange rate did not move (given the "Convertibility"), while the exchange rate of other countries was depreciated, so in terms of Argentina we have an appreciation.

Table 2: Variance decomposition

Variance decomposition of EMBI

Forecast Horizon	Percentage of the variance of the error made in forecasting EMBI due to			
	EMBI shock	Gov exp shock	GDP shock	Eff RER shock
1	100	0	0	0
4	88	7	5	1
8	88	7	5	1

Variance decomposition of Government expenditure

Forecast Horizon	Percentage of the variance of the error made in forecasting Government expenditure due to			
	EMBI shock	Gov exp shock	GDP shock	Eff RER shock
1	25	75	0	0
4	21	61	16	2
8	21	61	16	2

Variance decomposition of GDP

Forecast Horizon	Percentage of the variance of the error made in forecasting GDP due to			
	EMBI shock	Gov exp shock	GDP shock	Eff RER shock
1	35	13	52	0
4	35	14	48	4
8	35	14	48	4

Variance decomposition of Effective RER

Forecast Horizon	Percentage of the variance of the error made in forecasting Effective RER due to			
	EMBI shock	Gov exp shock	GDP shock	Eff RER shock
1	17	0	2	81
4	15	2	11	72
8	15	2	11	72

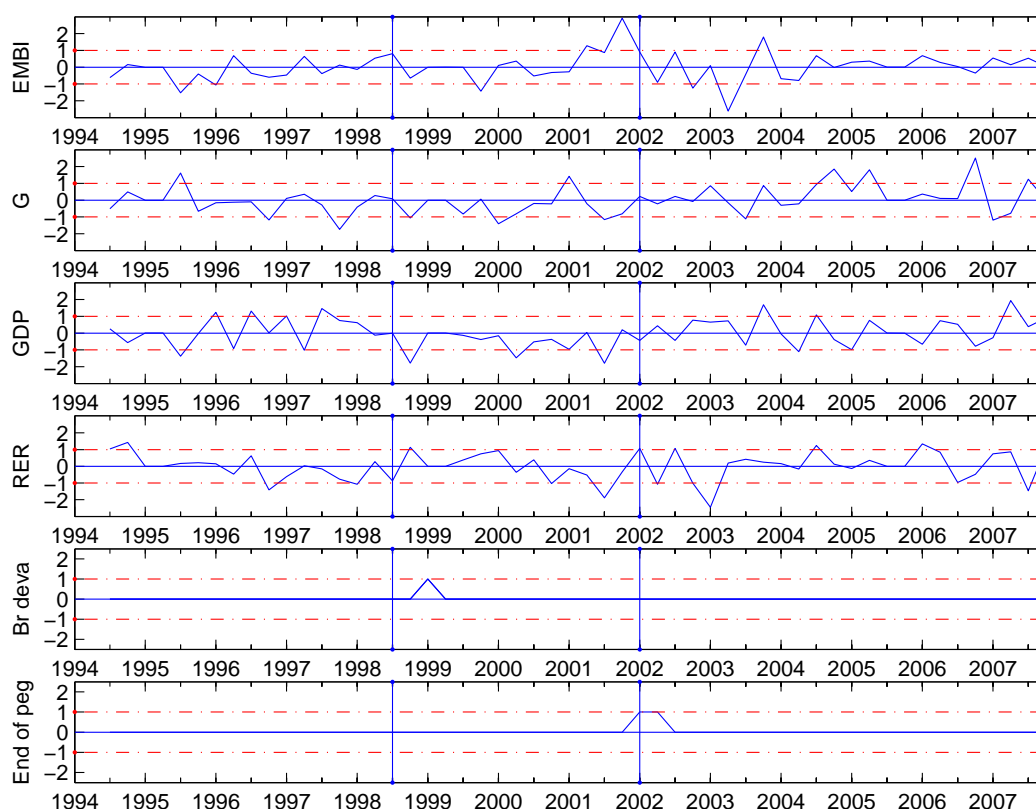


Figure 6: Estimated shocks, Brazilian devaluation dummy and end of peg and default dummy. In the first four panels one unit in the vertical axis indicates one standard deviation.

shock that we show in the fifth panel of Figure 6, had a significant negative effect on GDP as we have analysed in Section 5.1.5.

Sovereign spread remained at high levels after the 1998 shock, as we have discussed in Section 2.³⁴ This situation implied a restriction to finance an expansionary fiscal policy. Given this restriction, and trying to convince investors that fiscal policy was sustainable, several fiscal adjustment measures were taken. At the end of 1999 the Argentine Parliament approved the "Fiscal Responsibility Law". The norm included limitations to the increase in public expenditure with the intention to reduce the fiscal deficit to zero in 2003. The application of the law started in 2000, and several tax increases and expenditure cuts were implemented that implied contractionary fiscal shocks. As we can see in Figure 6, these measures implied several contractionary fiscal shocks.

The contractionary fiscal policy was complemented with financial actions trying

³⁴ According to Mussa (2002) IMF staff estimations in 2000 suggested that with a sovereign spread of 5-6%, the level of real interest rate in Argentina could have been high but compatible with growth, and also public debt dynamics could have been sustainable. In this hypothesis, could have been feasible avoid default and maintain the Convertibility regime. However with a spread of 10% or more it was unlikely that Argentina would have been able to grow. Furthermore with a spread of 10% or more the primary budget surplus necessary to stabilise public debt was so high that default could have been unavoidable. As we have seen in Table 1 EMBI was 4,4% during the first half of 1998, jumped to 7,6% in the second half and remained at this high level with some oscillations until 2001 where it jumped well above 10%. The spread passed the barrier of 10% on June 2001 and continued growing very fastly. At the beginning of December 2001, before the default was declared the spread was 40%.

to restore confidence and decrease sovereign risk. For example, at the end of 2000 an important package of 40 billion dollars of financial support led by the IMF was announced, (the plan was called "blindaje"). Sovereign spread experimented a short reduction during some period. In terms of our model we have some small EMBI shocks (implying an unexpected reduction of sovereign risk) in the second half of 2000.

The beneficial effects of these plans on the expectations were modest and the country risk started to rise again producing new EMBI shocks during 2001. Government expenditure decreases endogenously after an EMBI shock as we discussed in Section 5.1.1. Nevertheless the fiscal tightening was even more important and, as we can see in Figure 6, during 2001 we have additional contractionary fiscal shocks. The fiscal contraction was specially intense after the announcement in mid 2001 of the "zero deficit" policy. This policy implied a 13% cut in public wages and pensions benefits, and reductions in public investment. In Figure 6 we can see a fiscal shocks of -1,2 SD on 2001:III.

In July 2001, the run against the banks that started in 2000 was intensified and Central Bank reserves declined. As a consequence the available credit were diminished. Consumption and investment, that were decreasing during all the recession, dropped even more sharply. In our estimated model we see a GDP shock of -1,8 SD in the third quarter of 2001. This shock implied a GDP contraction added to the endogenous contraction originated in the EMBI and fiscal shocks.

Brazilian currency suffered during 2001 a new important depreciation that implied a new real appreciation for the Argentine peso. In the third quarter of 2001 we have a real exchange rate appreciation shock of 1,9 SD.³⁵

Finally in the fourth quarter of 2001, we have an important EMBI shock of 2,9 SD (EMBI attained an impressive 30% on average in 2001:IV).

These shocks implied a strong GDP decrease that was already decreasing for more than 3 years. At the beginning of 2002, in the middle of a social turmoil, the peso was allowed to float. In parallel the government decided a default on the public debt and the foreign currency deposits and credits in the banking sector were compulsory transformed into pesos. The end of the Convertibility implied a depreciation shock, and default resulted in an additional EMBI shock. As we commented we included a dummy for these events, that it is shown in the last panel of Figure 6. The effects of these events were discussed in Section 5.1.6.

5.4 Some considerations about the timing of the end of peg

The abandonment of Convertibility was accompanied with a default in public debt, a banking crisis and institutional problems. However, one question remains open: what would have happened if Argentina would have abandoned the Convertibility at the beginning of the recession?

The answer is not obvious, but the previous analysis seems to suggest that an early abandonment of the Convertibility could have had some advantages.

Argentine high degree of financial dollarization implied an important vulnerability in face of a real exchange rate adjustment no matter the exchange rate regime.

³⁵According to the work of Perry and Servén (2003), the real exchange rate of Argentina was appreciated with respect to its equilibrium value during the recession. In 2001 the real exchange rate become strongly misaligned, its deviation from equilibrium was estimated in 53%.

However, the lack of adjustment of the exchange rate, due to the Convertibility, implied that the adjustment had to be made through deflation and recession (given price rigidity). This type of adjustment aggravated the negative activity consequences of the balance sheet effects of the real exchange rate adjustment.

The financial position of many agents in the economy were aggravated by the long lasting recession and were added to the balance sheet effects of the final real exchange rate adjustment. The banking problems could have been less dramatic with an earlier adjustment.

The Argentine public debt, and its average interest rate, was not so high at the beginning. An earlier adjustment could have been better managed, and default could have been avoided or at least debt could have been restructured in a more friendly manner. However, during the recession, Argentine public debt over GDP increased in an important way, and also the interest rate paid by the debt increased.³⁶

Furthermore the adjustment was very slow and in the meanwhile Argentina suffered new real exchange rate appreciation shocks, as we analysed in Section 5.1.5. Finally after more than 3 years of recession the needed adjustment of the real exchange rate was probably higher and was made by a great exchange rate increase.

Our results seems to suggest that an early and ordered abandonment of the Convertibility could have been more beneficial than the chosen option. We derive this conclusion mostly from the fact that finally it was not possible to continue with the Convertibility and the regime change was made in the middle of a general turmoil.

However, a complete elucidation of the issue seems difficult with the empirical tools used in this paper. The issue could be better analysed in a theoretical model where the behavior of the system under different exchange rate regimes can be considered.³⁷

6 Robustness

In this section we analyse how the impulse response functions of Figures 2 and 3 behave in the two main subsamples. We also discuss how these impulse response functions change if we modify some of the assumptions of the benchmark specification.

6.1 Subsample stability

We run the model for the "Convertibility" period (1994-2001) and for the "Flexible exchange rate" period (2002-2007). On Table 3 we show the maximum GDP response to the different shocks in the two subsamples. According to our results the signs of the GDP response to the shocks seems to be the same in the two periods.

The effect of the EMBI shock on GDP seems to be more important during the Convertibility. One possible explanation of this behavior could be related to the fact that Argentina was excluded from international financial markets during the Flexible

³⁶ Argentine public debt over GDP was 37% in 1998. According to Calvo et al. (2003) if Argentine real exchange rate would have been adjusted 50% in 1998, the ratio would have jumped to 50%, a lower ratio than the Brazilian one, that realized a successful adjustment. However, in 2002 after the long lasting recession and final real exchange rate adjustment, the public debt over GDP reached 136%.

³⁷ For example, the already commented theoretical analysis of Céspedes et al. (2004) suggests that a flexible exchange rate regime could help to confront with adverse external shocks even in the presence of financial dollarization and balance sheet effects.

Table 3: Stability of GDP responses

Period	Maximum GDP response due to:		
	EMBI shock	Gov exp shock	Eff RER shock
1994-2001	-3,44 (7)	0,55 (2)	0,46 (8)
2002-2007	-0,70 (3)	0,53 (2)	0,45 (4)

exchange rate regime, given the default. Another explanation could be that the real exchange rate adjust less during Convertibility so the effect of the EMBI shock on GDP is amplified.

6.2 Other definitions of variables

We run the model using different definitions of the real exchange rate. One obvious candidate to this exercise is the real exchange rate with respect to Brazil that, as we saw, played a relevant role in the crisis. Using this specification the responses of the variables are basically the same that we reported here, with the exception of the response of real exchange rate to the EMBI shock. An unexpected increase of the sovereign spread that depreciates real effective exchange rate in our benchmark model, now initially depreciates but then appreciates the real exchange rate with respect to Brazil (the movements are not significant). This fact seems to be related to the different answer of Argentine and Brazilian monetary policy in face of the EMBI shocks (that were basically a common shock as we saw in Table 1). While Brazil opted for devaluate, Argentina maintained its peg, so the increase in EMBI (the "sudden stop" of capital inflows) is followed by an appreciation of the Argentine real exchange rate with respect to Brazil.

Another possible candidate is the real exchange rate with respect to the US, given that the Argentine economy was heavily dollarized (in particular public debt was in dollars) and also the peg was with respect to the dollar. The impulse responses under this specification are basically the same that we reported for the benchmark case. One interesting difference is that the appreciation of the real exchange rate in face of a fiscal shock is clearer in this case. This fact can provide an incentive to finance an unsustainable fiscal policy by issuing public debt in dollars. Another difference is that we are not able to see the real exchange rate appreciation shocks during the recession with this specification.

We also run the VAR with EMBI Brazil or with the composite EMBI instead of EMBI Argentina. These variables can reflect the credit conditions of the region (EMBI Brazil) or of the emerging markets (composite EMBI) and they are less likely to be affected by Argentine domestic factors not considered in the VAR, so it is more easy to interpret them as an external financial shock. We do not observe relevant changes in the results. In these two cases the responses of EMBI to the domestic variables shocks are less important, as expected.

In our baseline specification public spending is defined as the sum of wages, purchases of goods and services and public investment. We consider another definition including all the public spending. We run the VAR with this definition without observing relevant changes.

All variables, except EMBI, are deflated using GDP deflator. We consider two alternative options, we use the CPI as deflator of the government spending, and we consider another specification with the variables in real per capita terms. The results are similar to the benchmark case.

6.3 Alternative orderings and other specifications

As we discuss in Section 4 in our benchmark VAR we identify the EMBI shock assuming that EMBI is the most exogenous variable. We run the VAR assuming that EMBI is the most endogenous variable. Using this alternative the impulse response functions are similar to the benchmark case. The main difference between this alternative specification and the benchmark one is the relevance of the GDP response to the EMBI and fiscal shock. An unexpected EMBI increase conducts to a GDP decrease as in the baseline ordering, but now this effect is not significant. The effect of an EMBI increase on government expenditure is now negligible, while in the baseline specification we have a significant government expenditure decrease that reinforces the recessive effect of the EMBI shock. An unexpected rise in government expenditure leads to a GDP increase and to an EMBI decrease as in our benchmark results. However, the GDP and EMBI movements due to the fiscal shock are now more important. With this alternative specification the absence of a beneficial effect on GDP of a fiscal restriction via a credibility improvement is even clearer. The estimated shocks are similar, but now the EMBI shocks are smaller and the fiscal shocks are larger. The role of EMBI shocks as explanation of the crisis is now less relevant. In contrast, the role of the contractionary fiscal policy in the crisis is more important. Using this specification the decrease of government expenditure during the recession has no relation with the increase in sovereign risk, which seems implausible.

In our benchmark model real exchange rate can not affect contemporaneously GDP. We also run the model using a specification where GDP is affected in the same quarter by real exchange rate shocks. In this case the signs of the final responses of the variables to the four shocks shown in Figures 2 and 3 are the same. Nevertheless, there is a difference in the GDP response to a real exchange rate shock. Now, as in Figure 3 an unexpected real exchange rate depreciation leads to a GDP increase. However, in the first quarter GDP has a small decrease that it is reverted from the second quarter onwards. The final positive effect on GDP is not significant. As we discussed in Section 5.1.3 the minor GDP effects of this shock can be the consequence of the simultaneous operation of different channels with contradictory effects on output. Estimated shocks are almost identical to the shocks shown in Figure 6. The interpretation of the crisis is basically the same that we described in Section 5.3. The only exception is that the real exchange rate shocks identified with the general procedure are now less relevant as explanation of the crisis. However the interpretation of the role played by the two main real exchange rate shocks (the Brazilian devaluation and the end of the Convertibility) remains the same, given that they were identified by the dummy variable approach.

We also run the model without the dummies and the responses of the variables to the shocks are similar (in this case we have a more important effect of the real exchange rate shock).

In Annex G, Figure 7 we add the impulse responses under deterministic trends (DT

specification),³⁸ to the corresponding to the benchmark ST specification including the confidence bands. The responses of the variables to each shock are very similar to the corresponding to the baseline ST specification. In the majority of the cases the responses under DT enter into the ST confidence bands.

7 Conclusions

In this paper we study the role of financial shocks and macroeconomic policies during the Argentine crisis using VAR analysis.

Our analysis suggests that the crisis can be interpreted as the result of an adverse financial external shock, a "sudden stop" of capital inflows, amplified by local vulnerabilities. The significant negative effects of the EMBI shocks can reflect financial weakness. In Mourelle (2009) we provide evidence about the lack of strong fiscal sustainability in Argentina and Uruguay, aggravated in the Argentine case with reputational problems.

In this context, fiscal policy suffered financial restrictions. Furthermore, policy makers and multilateral financial institutions thought that a contractionary fiscal policy could have an expansive effect on GDP, via the drop in insolvency fears. As a result, fiscal policy was used in a contractionary way.

However, we find no evidence about an expansive effect on GDP of a contractionary fiscal policy in the Argentine case. Fiscal policy seems to behave in a more conventional way, and an unexpected movement of government expenditure seems to be followed by a GDP movement in the same direction. The contractionary fiscal policy implied that the GDP decrease was exacerbated by negative fiscal shocks.

Argentine experience suggests the convenience of avoid a contractionary fiscal policy during a recession. Two ingredients can help to this task: a strongly sustentable fiscal policy based on a tight fiscal behaviour during booms and better international liquidity provision mechanisms.

A devaluation can have negative consequences on a dollarized economy, via negative balance sheets effects on agents that have debts in foreign currency but assets in domestic currency (notably the public sector). However, allowing the exchange rate to move can help the adjustment process for an economy like Argentina after a shock. Preventing real exchange rate to adjust can have important output costs. The lack of adjustment of the real exchange rate favored the long lasting recession. The financial situation of the private and public sector was deteriorated as a consequence of the enduring recession.

The Convertibility prevented real exchange rate to adjust, and favored new appreciation shocks that aggravated the recession as we saw in Section 5.1.5.

Together with the exchange rate regime these shocks were the consequence of the lack of macroeconomic coordination inside the Mercosur. The asymmetric response of trading partners to a symmetric shock can be a source of problems as it is analysed by De Grauwe (2003). This was the case of the different response of Brazil and Argentina to the capital flows reversal.

These considerations suggest that a successful policy to prevent sudden stop crisis

³⁸ As we have commented, in the case of the benchmark ST specification the impulse responses have been accumulated so they are comparable with the responses under DT.

should include a de-dollarization process, exchange rate flexibility and macroeconomic coordination with the main trading partners.

For an emerging country with a pervasive financial dollarization it remains open the issue of the more convenient exchange rate regime to confront with adverse external shocks. Is it better a fixed exchange rate in order to avoid high movements of the real exchange rate and the associated balance sheet effects, or is it better a flexible exchange rate to minimize the output effects? In terms of the Argentine crisis, would have been better the results if Argentina would have abandoned the Convertibility at the beginning?

Our results seems to suggest that an early and ordered abandonment of the Convertibility could have been more beneficial than the chosen option. We derive this conclusion mostly from the fact that finally it was not possible to continue with the Convertibility and the regime change was made in the middle of a general turmoil.

However, a complete elucidation of the issue seems difficult with the empirical tools used in this paper. The issue could be better analysed in a theoretical model where the behavior of the system under different exchange rate regimes can be considered.

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A Data Appendix

EMBI and Effective real exchange rate are from JP Morgan. Public expenditure is from MECON. GDP, GDP deflator and CPI are from INDEC. Exchange rate is from the Central Bank of Argentina (BCRA). Public debt over GDP is from IADB.

Deposits, credits and unrecoverable credits are from the Central Bank of Argentina. These series were deflated with GDP deflator.

Foreign exchange reserves in the Central Bank are from IMF. Original data was in dollars, it was converted to pesos using exchange rate (BCRA) and deflated with GDP deflator.

Private consumption, exports and imports are from national accounts (INDEC). Quarterly private investment were estimated from annual private investment (INDEC) using Chow-Lin method with quarterly total investment from national accounts as high frequency indicator.

USA's CPI is from Bureau of Labor Statistics.

Brazilian exchange rate is from IMF, CPI is from Central Bank of Brazil.

B Unit root and Johansen tests

As we can see in Table 4, according to ADF test we can not reject the unit root hypothesis for the benchmark variables.³⁹

Table 4: ADF test

Variable	Statistic	5% critical value
EMBI	-1,33	-2,92
Gov. expenditure	-2,72	-3,51
GDP	-1,13	-3,50
RER	-1,00	-2,92

Note: All variables in logs except EMBI. Model with intercept and trend for Gov. expenditure and GDP, and with intercept for EMBI and RER. Lags according to AIC.

Table 5 shows the result of a Johansen test between the four benchmark variables. According to the test we cannot reject the hypothesis that the cointegrating rank between the four variables is zero.⁴⁰

Table 5: Johansen test

Ho: number of CE's	Trace test		Max eigen test	
	Statistic	5% critical value	Statistic	5% critical value
None	39,2	47,21	23,81	27,07

³⁹We also run ADF tests for the first differences of the variables in order to discard the I(2) hypothesis. We also perform Phillips Perron tests. In all the cases the tests seem to favoured the I(1) hypothesis for these variables.

⁴⁰As we commented in Section 4.3 in the results presented in Table 5 we assume a linear trend in the data. We also run the test assuming a quadratic trend without observing changes in the results.

C VAR order and residual tests

In Table 6 we can see that the lag order suggested by the Akaike criteria is one.

Table 6: Optimal lag order according to AIC criteria

Lag	AIC
0	-14,34
1	-14,40
2	-13,84
3	-13,97
4	-13,04

Table 7 shows the residuals behavior of the benchmark specification according to some standard tests.

LM and Portmanteau are multivariate tests for residual serial correlation up to the specified order (h). LM tests are more appropriate for small values of h , and Portmanteau tests are more suitable for a large h (h has to be, at least, higher than the lag order).

Hetero is an extension for systems of equations of the White (1980) test for Heteroskedasticity. Normality is the multivariate Jarque-Bera test. ARCH is a multivariate ARCH-LM test.

As can be seen in Table 7 our model seems to have a good behavior in terms of whiteness and normality and they do not show evidence of ARCH behavior. At 1% significance level our model satisfy the tests reported in Table 7.⁴¹

Table 7: Residual tests

Test	LM		Portmanteau		ARCH		Normality	Hetero
	$h=1$	$h=4$	$Q(h=8)$	$Q^*(h=8)$	$h=1$	$h=4$		
Statistic	17,88	15,09	120,64	131,95	102,40	393,68	16,28	156,52
p-value	0,33	0,52	0,27	0,10	0,41	0,58	0,04	0,96

⁴¹ As in the other cases, we cannot reject normality at the 1% significance level. The p-value is close to 5%. However, we can reject normality if we apply a more tough criteria. The residuals distribution is flat relative to the normal, a problem related with the important quantity of dummies that we have used. If we use a lower number of dummies, we have a better behavior in terms of normality. For example, if we run the model using only the dummy for the end of peg and the dummy for the swap the p-value of the Jarque-Bera test is 0,39. In this case we have similar results to the ones reported in Section 5. However, the behaviour of the model in terms of subsample stability is worse so we opted for the inclusion of the dummies presented in Section 4.3.

D Pseudo out of sample forecasts

We compute simulated out of sample forecasts over the period from 2006:I to 2007:IV. We examine forecast horizons of one quarter, two quarters and three quarters. As in Stock and Watson (2001) we estimate the forecast h steps ahead by running the VAR through a given quarter, making the forecast h steps ahead, running again the VAR through the next quarter, making again the forecast h steps ahead, and we continue like this until the end of the forecast period. We then compute the square root of the average squared value of the forecast error over the forecast period. The result of this exercise is shown in Table 8. We show the results for our baseline specification, VAR with one lag, as it is suggested by AIC criteria, and for the same VAR but with 4 lags, a benchmark that it is used in some papers. In both specifications we include a constant, seasonal dummies and the dummies that we commented in Section 4.

As we can see in Table 8 our benchmark specification is more efficient forecasting than the specification with 4 lags. We use this evidence as a complementary criteria to choose the more parsimonious model as we commented in Section 4. We also compute the same exercise using other number of lags, (not showed in the Table). Our benchmark specification seems to have better forecast performance than these other options.

Table 8: Root Mean Squared Errors of Simulated out of sample forecasts. Argentina: 2006:I-2007:IV

Forecast Horizon	EMBI		Gov. Exp.		GDP		Eff RER	
	VAR(1)	VAR(4)	VAR(1)	VAR(4)	VAR(1)	VAR(4)	VAR(1)	VAR(4)
1	0,01	0,14	0,09	0,15	0,02	0,03	0,02	0,08
2	0,02	0,15	0,13	0,22	0,03	0,08	0,03	0,12
3	0,03	0,19	0,11	0,33	0,04	0,14	0,03	0,15

E The dummy variable approach

The dummy variable approach was developed by Romer and Romer (1989) to study monetary policy.⁴² The approach has been used to identify other type of shocks. In particular this approach has been widely used to identify fiscal shocks after the work of Ramey and Shapiro (1998). Following Perotti (2007), in the case of a fiscal shock, the approach consists in identifying episodes of unexpected government expenditure expansion. For example Ramey and Shapiro (1998) identify 3 episodes of unexpected increase of defense spending: Korean War, Vietnam War and the expansion of defense spending under Reagan. Perotti (2007) adds the expansion under Bush administration after 2001. We define D_{1t} , D_{2t} , D_{3t} and D_{4t} , that takes the value of 1 at the beginning of the episode of fiscal expansion and 0 otherwise. In the "first version" of the dummy variable approach ("DV1"), we defined the combined dummy variable as $D_t = D_{1t} + D_{2t} + D_{3t} + D_{4t}$. Then we estimate the reduced form VAR:

$$X_t = A(L)X_{t-1} + B(L)D_t + U_t \quad (1)$$

where X_t is a vector of endogenous variables including in this case government spending, taxes and output, $A(L)$ is a polynomial of order n_A , $B(L)$ is a polynomial of order n_{B+1} and U_t is the vector of residuals. Then, the effect of this shock on the endogenous variables at $t+k$ is given by the estimated coefficient on L^k in the expansion of $(I - A(L)L)^{-1}B(L)$.

Perotti (2007) proposes three other versions of the approach. In our case, it will be of interest the "DV3" version that implies that the responses to each episode can be different. This can be the case if for example each episode has different intensity or if each episode is a different combination of changes in expenditure and taxes. For example the expenditure expansion of Korean War was accompanied of increased taxes, while the spending expansion of Vietnam War came with tax cuts. In this case we estimate:

$$X_t = A(L)X_{t-1} + \sum_{i=1}^4 B_i(L)D_{it} + U_t \quad (2)$$

where each $B_i(L)$ is a vector polynomial of order $n_B + 1$.

In our case X_t consists of four variables: EMBI, government expenditure, GDP and real exchange rate. We have 4 dummies, and each one consists of episodes of different intensity and that implies different combination of changes in the variables. We will concentrate in the effect of two of these dummies: the Brazilian devaluation dummy and the "end of peg and default" dummy. In the case of the Brazilian devaluation, the episode is a real exchange rate shock that implies an appreciation for Argentina. In the case of the "end of peg and default", the episode will be basically the combination of a real exchange rate shock that depreciates the Argentine currency (associated with the abandonment of Convertibility), and an EMBI shock (associated with the default).⁴³

⁴²See the discussion about the dummy variable approach in Tiscordio and Bucacos (2009).

⁴³The "end of peg and default" shock probably include an exogenous component of negative GDP shock, due to the collapse of the banking system and the institutional turmoil.

F Shocks

In this appendix we explain how to obtain the shocks that we show in the first four panels of Figure 6.⁴⁴

As we commented in Section 4.2 we first estimate a reduced form VAR like the one presented in equation 2, where U_t is the vector of reduced form residuals at date t ($U_t \sim i.i.d.N(0, \Omega)$).

For a given sample T , we can estimate by OLS the reduced form covariance matrix, $\hat{\Omega}$, as follows:

$$\hat{\Omega} = (1/T) \sum_{t=1}^T \hat{U}_t \hat{U}_t' \quad (3)$$

where the i th element of \hat{U}_t is the OLS sample residual for the i th equation in the VAR for date t . In our case \hat{U}_t is a (4x1) vector (given that we have 4 endogenous variables) and we have one \hat{U}_t for each t ($t=1,2,\dots,T$), $\hat{\Omega}$ is a (4x4) matrix.

The identification procedure that we saw in Section 4.2 implies the computation of the Cholesky factorization of the reduced form covariance matrix with the variables in the order that were presented at the beginning of Section 4.1.

The Cholesky factorization can be written:

$$\hat{P} \hat{P}' = \hat{\Omega} \quad (4)$$

where \hat{P} is a (4x4) lower triangular matrix. Using this matrix we can construct a (4x1) vector \hat{v}_t from

$$\hat{P}' \hat{U}_t = \hat{v}_t \quad (5)$$

We have one \hat{v}_t for each t ($t=1,2,\dots,T$). These shocks were the ones that we represent in the first four panels of Figure 6. These disturbances are consistent with the identification procedure used to derive the Impulse response functions shown in Figures 2 and 3.

⁴⁴ A similar discussion to the one presented here, can be found in Chapter 14.4 of Hamilton (1994).

G Robustness

In this appendix we show how the impulse response functions of the benchmark specification (see Figures 2 and 3) change when we consider a deterministic trend (DT) instead of the stochastic trend (ST).

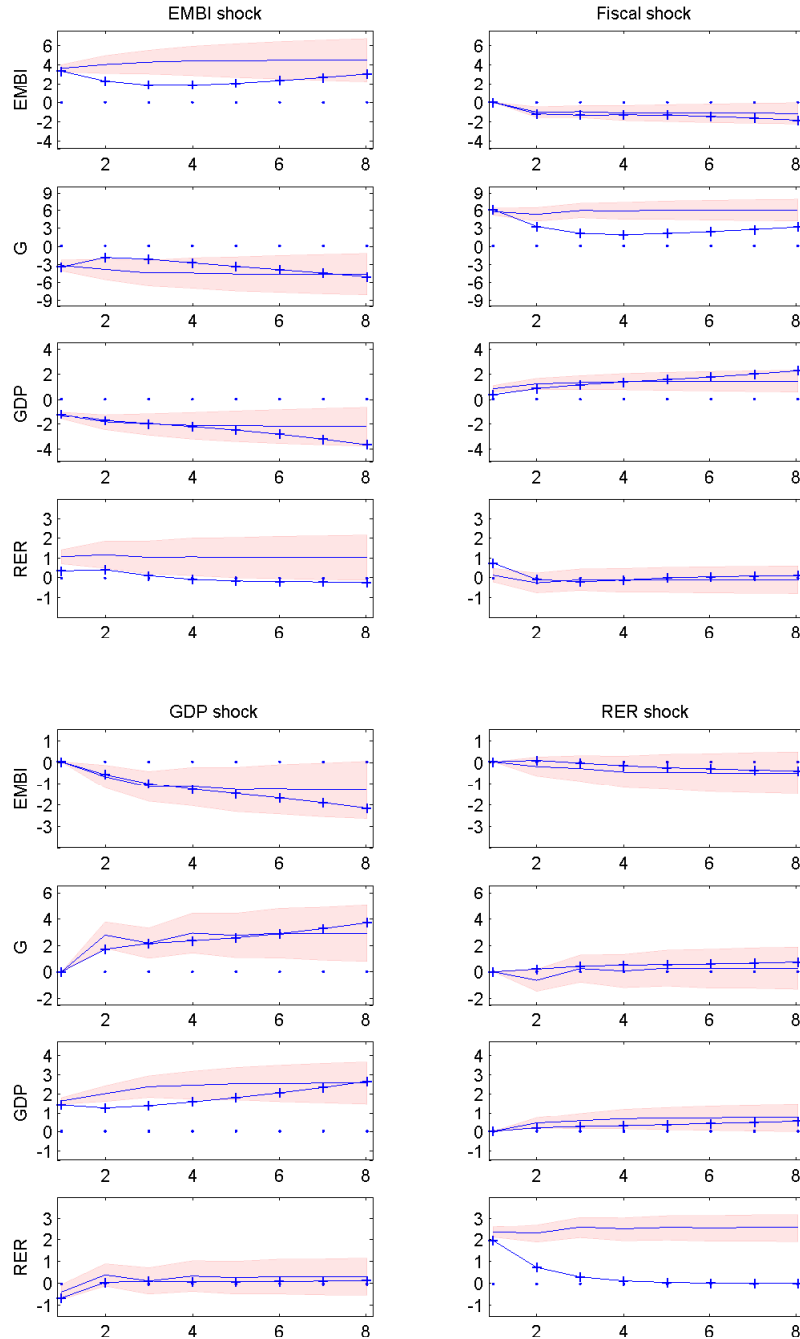


Figure 7: Impulse Response Functions under benchmark ST specification and under DT. Shaded area indicates 1 SE confidence bands of ST specification. $-$: ST; $+$: DT.

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