UNIVERSITÉ CATHOLIQUE DE LOUVAIN

Faculté des sciences économiques, sociales, politiques et de communication

Economics School of Louvain

MACROECONOMIC POLICIES AND FINANCIAL SHOCKS IN DOLLARIZED ECONOMIES

José MOURELLE

Thèse présentée en vue de l'obtention du grade de docteur en sciences économiques

Jury:

Supervisors:

Prof. Vincent Bodart (*Université catholique de Louvain*)
Prof. Em. Henri Sneessens (*Université catholique de Louvain*)

Other members of the Jury:

Prof. Javier Garcia-Cicco (*Universidad Católica Argentina*)
Prof. Luca Pensieroso (*Université catholique de Louvain*)
Prof. Céline Poilly (*Université Aix Marseille*)
Prof. Paul Reding (*Université de Namur*)

July 2020

A mi familia

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Acknowledgements

First of all I would like to thank Henri Sneessens for his steady support during all these years. I am very grateful for his advices, for his careful supervision over all my work and for sharing with me his knowledge and experience. He believed in me and he always found the way to encourage me in difficult moments.

I am very grateful to Vincent Bodart who accepted to be my co-supervisor and made me a lot of suggestions that improved the quality of this dissertation. He was also my thesis supervisor in the Master, and he helped me from the very beginning of this project.

Much of the work presented here benefited from invaluable suggestions by Javier García Cicco. This thesis would not be the same without his advise.

I would like to express my gratitude to the other members of the jury that made me very useful suggestions. Paul Reding provided me very constructive comments that helped me to improve this final version. I am indebted to Céline Poilly and Luca Pensieroso that gave me useful comments in the pre-defense and also helped me a lot during all the process of the dissertation.

I would like to acknowledge financial support provided by the European Union through the Programme Alβan (scholarship No.E06D103630UY), by the Banco Central del Uruguay, by the Department of Economics of the Université catholique de Louvain, and by the Universidad de la República.

My deepest gratitude goes to the administrative and technical staff at UCL for their hospitality and for their support. A very special thanks to Isabelle, Claudine, Severine, Paul, Jean-Claude, Jean-Pierre, Thérèse, Marie-Hélène, Pascale, Anne, Marie, Solange and Anne-Marie.

I also would like to mention the people that I had the chance to meet and share unforgettable moments in Louvain: Choco, Alfonso, Sebastian T., Fabio, Gilles, Marco, Fernanda, Florencia, Anna, Erwan, Petros, Antonio, Oscar, Davide, Pulpo, Daniel, Carmen, Alberto, Laura, Maru, Francesco, Andrés, Juan Pablo, Anita, Mauri, Gris, Milena, Lorenzo, Gabriel, Feña, Vivi, Luca, Alain, Pierre, Bastien, Tanguy, Skerdi, Esteban, Paulo, Juan Manuel, Thierry, Guadalupe, Guillermo, Danilo, Seba, Gaby.. and I apologize to those who I forgot.

I wish to thank my colleagues from the Banco Central del Uruguay and the UDELAR, that encouraged me to finish my dissertation and gave me useful comments during this time. In particular I would like to thank Fernanda that helped me with the edition and gave me valuable suggestions. I also received permanent support and suggestions from Leonardo, Diego A., Conrado, Gerardo, Fernando, José Antonio, Umberto, Jorge, Enrique, Margarita, German, Juan Carlos, Diego G., Elizabeth, Serafín, Miguel, Rodrigo, Gabriela, Patricia, Helena, Esteban, Adriana, Daniel, Alberto, Alejandro, Verónica, Matías, Andrés, Adolfo, Laura, Mónica, Bettina, Gwendoline and many others.

Finalmente quisiera agradecer a toda mi familia y amigos, en especial a mis padres, a mi hermano Carlos y a Florencia por el cariño y el apoyo durante todos estos años. A Loly, Pía y Manu, gracias por esperarme todos estos años y por darme cada día más ganas de vivir.

General Introduction

This dissertation analyses the interaction between macroeconomic policies and financial shocks in small open and dollarized economies.

In emerging economies agents usually resort to borrowing in foreign currency. If the economy is hit by an external shock the monetary authority can be exposed to a difficult dilemma. Depreciation of the national currency can help to accommodate the shock, but it can have harmful consequences to agents that have their debt in foreign currency, but their assets and income in local currency. This situation affects firms in non-tradable sector, but also households and the government. However, if the authorities prevent the nominal exchange rate to change, the economy can go by a deflationary process that can also induce financial problems.

Fiscal policy is usually conducted in a procyclical way in emerging economies, as it is documented, among others, by Kaminsky, Reinhart, and Végh (2004) and Végh and Vuletin (2012). This adds a source of instability and amplification of the effects of the external shocks. These problems were common in Latin America and other emerging countries and were at the center of the stage in the Argentine and Uruguayan crisis of 2001-2002. Similar problems can arise in the case of a small economy that is part of a monetary union (that is an extreme case of fixed exchange rate), as happened in the recent Greek crisis.

The results that are shown in this dissertation suggest the convenience of a flexible macroeconomic policy framework to deal with these types of shocks, and in particular, the convenience of a countercyclical fiscal policy.

Chapter 1 analyzes this kind of problems providing a first extensive comparison between the Argentine and Uruguayan crises of 2001-2002. The economic process that experienced Argentina and Uruguay from the early 90s till the aftermath of the crises is analyzed with emphasis in the role played by the exchange rate and fiscal policies followed by the two countries.

The evidence reported in the chapter suggests that in both cases the crises can be understood as the result of an adverse external shock in a vulnerable environment. However, the same shock had some different effects in a similarly dollarized economy. These different outcomes were related to a more flexible monetary policy in the Uruguayan case which facilitated a more gradual adjustment of the real exchange rate. Uruguay enjoyed better credit conditions during the recession which derived in a different public debt dynamic. There was no clear difference in terms of fiscal sustainability between Uruguay and Argentina. Different credit conditions seem to reflect a different reputation.

The chapter concludes that given that internal factors seem to have played a key role in the crises, the most pernicious effects of the sudden stops could be avoided by a combination of a sustainable (and countercyclical) fiscal policy, a flexible monetary policy and a less dollarized economy.

Chapter 2 analyzes the role played by external and internal forces during the Argentine Convertibility (1991-2001) and its collapse. The focus of the chapter is on the kind of shocks that generated the recession events that happened during this period and on the factors behind the collapse of the Convertibility.

The Convertibility was a stabilization plan that implied a currency board, the exchange rate was fixed by law in 1 Argentinean peso equal 1 *US*$. Four years after the launching of the Convertibility Plan, Argentina suffered a recession associated to the spillovers of the Mexican "tequila crisis". After this event, Argentina started

to grow again. However, after the Russian default of August 1998, Argentina suffered another important GDP drop followed by a long-lasting period of economic slowdown. This process finally ended in 2001 with a big fall of output and the fixed exchange rate regime was abandoned in January 2002.

The causes of the Argentine crisis of 2001 2002 have been under an important debate. However, there has been little formal empirical analysis with the aim to clearly disentangle the role of external and internal forces in the process. One study that provides a formal quantification of the contribution of external and internal shocks to the crisis is the paper of Kaminsky et al. (2009) that focus on reserves loses. Compared with that article in this chapter a more careful division between external and domestic factors is provided and the focus is directly on the GDP losses. The impact of the shocks in GDP are estimated using the local projections method proposed by Jordà (2005). This method has been extensively used in recent applied macroeconomic research.

To characterize in a precise way the impact of external and internal forces in the GDP performance, a simple model is developed. After that, and using the guide provided by this model, a three-step procedure is followed. First, an external VAR is used to obtain the external shocks. Second, using the external shocks as exogenous variables, domestic shocks are obtained from an internal VAR. Finally, the local projections methodology is used to generate the dynamic responses of GDP to external and domestic shocks. Using the impulse response function obtained with the local projection method and the shocks, the contribution of the different sources of fluctuations to the GDP is derived. The three contractionary episodes that happened during Convertibility are analyzed in detail.

The relative importance of external and internal forces seems to vary according to the contractionary episode analyzed. In the "tequila crisis" episode, domestic financial shocks (expressed in the increase of the excess Argentine spread) seems to have played the main role. In the Russian crisis episode, the external influences represented by external financial shocks and the Brazilian devaluation seems to have been the main responsible for the GDP drop. Finally, in the end of the convertibility, a mix of external forces expressed in the recession and depreciation of the commercial partners and internal vulnerabilities, in particular excess Argentine spread shocks, explained the GDP problems. These results have some differences with the ones of Kaminsky et al. (2009), where almost no role for external shocks in the end of Convertibility is identified. The important role played by the excess spread shocks during the tequila crisis and in the end of the Convertibility can reflect lack of investors' confidence in the Argentine public debt sustainability associated in turn with the recurrent Argentine fiscal problems.

Finally, in Chapter 3 a theoretical model is developed to analyze the optimal combination of cyclical behavior of fiscal policy and exchange rate flexibility in a small open economy with sticky wages, dollarized debt, and where corporate risk premium is determined by domestic net worth. Monetary policy can allow exchange rate to adjust to market conditions (flexible exchange rates), or can fix it, or can adopt an intermediate exchange rate regime. Public sector collects taxes, and issues public bonds in international markets in foreign currency. The government can follow a countercyclical fiscal rule, a procyclical fiscal rule or a neutral one.

Although many papers study the optimal exchange rate regime or the optimal cyclicality of fiscal policy, there are no studies (to the best of our knowledge) that analyze both at the same time, that is the goal of this chapter.

In the presence of an external shock, flexible exchange rates dominate fixed exchange rates when fiscal policy is neutral. The desirability of flexible rates is not

affected by the importance of financial imperfections. The external shock requires a real devaluation, that can be reached by two ways: nominal depreciation (flexible exchange rates) or deflation (fixed exchange rates). In both cases we have negative balance sheet effects, but with fixed exchange rates (and nominal rigidity) we have an additional recessive effect.

The recessive effect of fixed exchange rates is mitigated when fiscal policy is countercyclical. In the case of a very tough countercyclical fiscal policy, we are close to replicate (via fiscal policy) the output result of flexible exchange rates. This result has similarities with the one of the "fiscal devaluations" literature.[1]. This literature focuses in one specific combination of macroeconomic policies: a fixed exchange rate combined with a fiscal policy that tries to replicate the results of nominal exchange rate depreciation. Our chapter places this combination in a broader perspective. The system seems to be more stable under a countercyclical fiscal policy. On the contrary under a strong pro-cyclical fiscal policy the equilibrium is not determined.

A second-order approximation to the utility of the representative consumer, is used to compute expected welfare losses associated to different combinations of policies in the case of a financial shock, and to select the one that minimizes these losses.

Our analysis suggest that a countercyclical fiscal policy dominates other alternatives (procyclical or neutral fiscal policy). A countercyclical fiscal policy can help households to do what they would do if they have the means to do it (smooth consumption).

The choice of the exchange rate regime is a second-order decision when fiscal policy is countercyclical enough. A flexible exchange rate policy seems to be required if fiscal policy is not sufficiently countercyclical.

[1] Se for example the paper of Farhi, Gita, and Itskhoki (2014). This literature was inspired by the situation of some countries inside the Euro area, specially Greece.

1 Fiscal and exchange rate policies during the Argentine and Uruguayan crises of 2001-2002

The purpose of this chapter is to provide a first extensive comparison between the Argentine and Uruguayan crises of 2001-2002. The economic process that experienced Argentina and Uruguay from the early 90s till the aftermath of the crises is analyzed with emphasis in the role played by the exchange rate and fiscal policies followed by the two countries.

I find that in both cases the crises can be understood as the result of an adverse external shock in a vulnerable environment. However, the same shock had some different effects in a similarly dollarized economy. These different outcomes were related to a more flexible monetary policy in the Uruguayan case which facilitated a more gradual adjustment of the real exchange rate. Uruguay enjoyed better credit conditions during the recession which derived in a different public debt dynamics. There was no clear difference in terms of fiscal sustainability between Uruguay and Argentina. Different credit conditions seem to reflect a different reputation.

The analysis of the Argentine and Uruguayan crises shows that internal factors play a key role in the economy response to a sudden stop. This fact suggests that the most pernicious effects of these shocks could be avoided by a combination of a sustainable (and countercyclical) fiscal policy, a flexible monetary policy and a less dollarized economy.

1.1 Introduction

Argentina and Uruguay experienced during the 1990's an important growth process, with a decreasing inflation and a declining public debt to GDP ratio. Both countries had their currency pegged to the US dollar.

The Russian default of August 1998 led to a sudden stop in capital inflows to emerging economies and Latin America economies in particular. In the second part of 1998 a recession started in Argentina and Uruguay. The recession derived in a deep crisis in 2001-2002 when finally the two countries abandoned their peg.

The abandonment of the peg implied a huge devaluation that led to a great increase in the burden of the public debt that was mostly denominated in foreign currency. Argentina finally defaulted in 2002, and the posterior debt restructuring process included an unprecedented haircut. The Uruguayan public debt was market friendly restructured in 2003. The different resolution of the public debt crisis was in part explained by the worse credit conditions that suffered Argentina during the long lasting recession.

During the European debt crisis an Uruguay-style debt restructuring was suggested as a possible solution to the fiscal problems of some European countries. The Argentine example was mentioned as a quite different option.[1]

Many papers have analyzed the Uruguayan crisis and the Argentine one separately.[2] However there is a lack of studies that compares the two processes, which is the objective of this work.

This chapter analyzes the similarities and differences in the fiscal and monetary policies followed by Argentina and Uruguay. In particular it discuss what factors explain the long lasting recession suffered by these countries. The chapter, by comparing the two processes, shows how different exchange rate flexibility and different credit conditions can lead to different crisis dynamics.

In particular, the sustainability of Argentine and Uruguayan fiscal policies are analyzed. The chapter tries to check if the different credit conditions of Argentina and Uruguay were related to a different situation in terms of fiscal sustainability. Cointegration analysis between government expenditures and revenues suggests that fiscal policy was sustainable only in a weak sense in Argentina and Uruguay. This situation facilitated the speculative attacks suffered by both economies. There was no clear difference in terms of fiscal sustainability between Uruguay and Argentina. This suggests that different credit conditions were originated in reputational considerations.

The analysis of the Argentine and Uruguayan crises shows that internal factors play a key role in the economy response to a sudden stop. This fact suggests that the most pernicious effects of these shocks could be avoided by a combination of a sustainable (and countercyclical) fiscal policy, a flexible monetary policy and a less dollarized economy.

The chapter is organized as follows. Section 1.2 develops some theoretical explanations about the Argentine and Uruguayan crises. Section 1.3 analyzes the evolution of the Argentine and Uruguayan economies during the 1990's, centered in the monetary and fiscal policies, the financial vulnerabilities, and the regional integration process. Section 1.4 studies the development of the crisis with emphasis in the role played by macroeconomic policies. Section 1.5 reviews the final stage of the crisis, and the macroeconomic polices followed after the crisis resolution. Finally, Section 1.6 concludes.

1.2 Main explanations of the Argentine and Uruguayan crises

This section analyzes some possible theoretical explanations about the Argentine and Uruguayan crises. In the rest of the chapter the development of the crisis is discussed following these lines of interpretation.

1.2.1 Internal vulnerabilities. The balance sheet approach

One line of interpretation is that these economies had several internal vulnerabilities that made the economies more prone to a crisis.

[1] See for example Reinhart and Rogoff (2011), IMF (2013), Lavdas, Litsas, and Skiadas (2013) and Grund (2016).

[2] Among others, see the papers of Damill, Frenkel, and Rapetti (2005), Perry and Serven (2003), Powell (2002), Mussa (2002), Hausmann and Velasco (2002), De Brun and Licandro (2005) and De Brun and Della Mea (2003)

Among these vulnerabilities the literature about the 'balance sheet approach' has drawn attention to problems related with the financial structure of the economy.

Following Allen et al. (2002) this approach emphasizes the role of stock variables (assets and liabilities) in sectoral balance sheets or in the country's aggregate balance sheet. In this view the crisis is the result of a drop in the demand of financial assets of one or more sectors of the economy, for example a fall in the confidence in the government ability to pay external debt or in the banking system capacity to honor deposits. This could lead to an increase in the demand for foreign assets and ultimately to capital outflows. These usually is accompanied by exchange rate depreciation, current account surpluses and recession.

The approach considers four types of balance sheet mismatches: a) maturity mismatches; b) currency mismatches; c) capital structure problems and d) solvency problems.

In the presence of maturity mismatches, a situation where typically short term debt is higher than liquid reserves, the sector is exposed to roll-over risk and to interest rate risk. Under currency mismatches (debts and assets denominated in different currencies) a sector is exposed to exchange rate risk. Capital structure problems (firms with too much debt related to equity financing) may imply difficulties in face of a revenue shock. Finally solvency problems implies that liabilities are higher than assets.

Although these four types of balance sheet mismatches were present in the Argentine and Uruguayan crises, the literature and the evidence that it will be revised afterwards suggests that currency mismatches played a key role in the Argentine and Uruguayan crises. In the next subsection the focus will be on this problem. Solvency concerns about public debt were also an important ingredient of the crisis. This topic is analyzed in section 1.2.2. In particular, fiscal solvency in Argentina and Uruguay will be discussed in section 1.3.2.

Dollarized balance sheets

According to Allen et al. (2002) in emerging economies agents usually resort to borrowing in foreign currency from non-residents and also from residents. The attempts of some sectors to reduce the exposure to currency risk normally only leads to increase the currency risk of other sectors. In particular, banks that receives deposits in dollars can in theory reduce their currency mismatch by lending in dollars, but by this way they could be increasing the risk of unpaid credits in a devaluation. This problem is magnified when exports are small compared to internal debts in dollars. In this case firms can have difficulties to hedge against exchange rate shocks.

A high degree of de facto dollarization can impose an important rigidity to a fixed exchange rate system. If the circumstances suggest the necessity of devaluate, the authorities can be exposed to a difficult dilemma. Under an important degree of financial dollarization a devaluation could have negative consequences on the balance sheets of numerous agents of the economy, that had their debts denominated in foreign currency but their assets denominated in domestic currency, as it is suggested, among others by Mishkin (1999), Calvo and Reinhart (2002) and Krugman (1999). This was the situation, in Argentina and Uruguay, of the firms that operate in the non tradable sector. The same situation affected the households and the government that collected taxes in home currency, but had their debt mostly issued in foreign currency. The banks were also prone to be affected

by a devaluation through their balance sheets and by means of the increased credit risk of their debtors.

These issues are discused on sections 1.3.3 and 1.4.4.

1.2.2 Internal vulnerabilities. The role of macroeconomic policies

Another type of internal vulnerabilities were related with the design of the fiscal and exchange rate policies.

Fixed exchange rate regime

According to Allen et al. (2002) fixed exchange rate regimes were an important ingredient in the financial crisis of the 1990s.[3] Exchange rate stability (sometimes combined with expectations of real exchange rate appreciation) can encourage domestic agents to run up excesive debts in foreign currency. At the same time a pegged exchange rate regime, combined with nominal rigidity, makes a country more vulnerable to shocks. Moreover, as was commented previously a high degree of financial dollarization generates an incentive to not devaluate in order to avoid the negative balance sheets effects in the agents with dollarized debts (which usually includes the own public sector).

Céspedes, Chang, and Velasco (2004) analyzes this dilemma in an dollarized open economy model with nominal ridigities and concludes that fixed exchange rates are worst to confront with adverse external shocks than flexible rates. The reason is that the shock requires a real devaluation that can be accomplish either by nominal depreciation (flexible rates) or by deflation and recession (fixed rates). Balance sheets effects are present in both cases, but flexible exchange rates avoids the recessive effect associated with the deflation.

According to Bubula and Otker-Robe (2003) pegged regimes, have been more crisis prone than floating regimes, for countries that are more integrated with international capital markets during 1990-2001. Their paper also suggest that intermediate regimes (soft pegs and tightly-managed floating regimes) were more susceptible to crises that hard pegs and floating regimes in this period.

Fixed exchange rates can promotes financial dollarization. In particular, under a stabilisation plan based on an exchange rate peg, the authorities have to convince the agents that the exchange rate is under strict control. This generates little incentives to implement a policy that prevent the non-tradable agents from taking credits in dollars. Such a policy would have as main argument that a devaluation can have negative consequences on the balance sheets of the agents of the non tradable sector.

Procyclical and non sustainable fiscal policies

Fiscal policy has been mainly procyclical in emerging economies, as it is documented by Kaminsky, Reinhart, and Végh (2004) and Végh and Vuletin (2012). As will be analyzed in Chapter 3, pro-cyclical fiscal policy is associated with a less stable environment, and with more output and consumption volatility. When this pro-cyclical fiscal policy is combined with a financially vulnerable situation and a fixed exchange rate regime, the recession provoked by a negative external shock

[3] Barkbu, Eichengreen, and Mody (2011) suggest that fixed exchange rate also could have complicated the macroeconomic adjustment in the european debt crisis.

is deepened. A procyclical fiscal policy increases the probability of being in a financially vulnerable situation. The economy is less stable under this kind of fiscal policy, and under a strong pro-cyclical fiscal policy the equilibrium is directly not determined. These conclusions are derived from a model similar to Céspedes, Chang, and Velasco (2004) with the addition of a public sector that has a dollarized debt.

Pro-cyclical macroeconomic policies is considered one of most important amplifiers of boom-bust cycles according to Reinhart (2012).

Another element that seems to have played an important role in the Argentine and Uruguayan crises is the lack of fiscal sustainability. According to Allen et al. (2002) government solvency concerns was one important component of the Argentine crisis when a dollarized debt and an important real depreciation provoked an abrupt jump in the public debt. It can be argued that the lack of fiscal sustainability could also promotes financial dollarization. An unsustainable fiscal policy can encourage the appreciation of the national currency. This appreciation will increase the GDP in dollars, and can decrease the public debt to GDP ratio if public debt is denominated in dollars, even if the public debt is increasing. This generates an incentive to finance an unsustainable fiscal policy by issuing public debt in foreign currency. The fiscal sustainability in the Argentine and Uruguayan cases will be analyzed in section 1.3.2.

1.2.3 External factors

One complementary line of explanation of the crisis is related with external factors. In particular at the begining of the recession, that finally conducted to the crisis, these economies suffered a sudden stop of capital inflows. The impact of this capital flows reversal was magnified by the lack of coordination inside the Mercosur agreement, where Brazil abandoned the exchange rate peg, while Argentina and Uruguay decided to mantain the peg.

Capital inflows and sudden stops

Large capital inflows is one of the principal antecedents of financial crisis as it is described by Reinhart (2012). An important increase in private and public indebtedness and in asset prices is often associated with capital inflows.

If these capital inflows suffer a "sudden stop" the economy could be expose to bankruptcies, destruction of human capital and local credit channels, according to Calvo (1998). These negative impacts could be higher the higher is the share of consumption financed by capital inflows, and the higher is the importance of short-term financing.

The sudden stop in capital inflows to Latin America economies that followed the Russian default in 1998 was the main explanation of the beginning of the recession in Argentina and Uruguay, as we will see in section 1.4.1.

Lack of coordination inside the Mercosur process

The pegged exchange rate regime that prevails in Argentina, Brazil and Uruguay until the devaluation of the real in 1999, can be seen as a sort of incomplete monetary union, with similarities with the Exchange rate Mechanism (ERM) applied in the European Union until the adoption of the Euro.

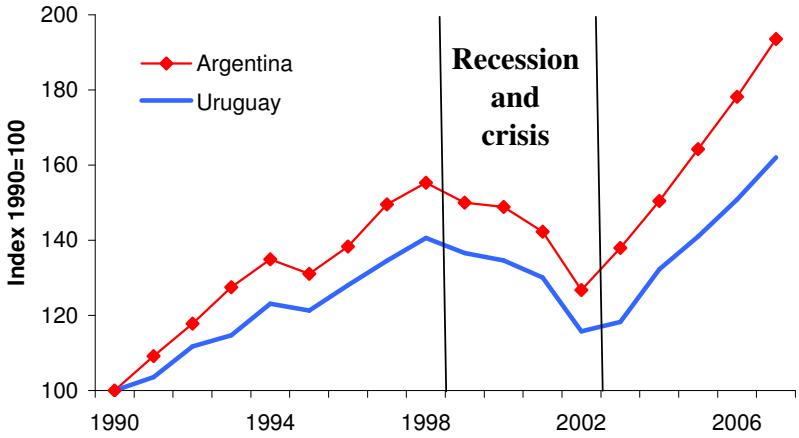


FIGURE 1.1: Argentina and Uruguay: GDP, 1990-2007

Following De Grauwe (2003) these kind of systems often have credibility problems and are hit by speculative crisis. The likelihood of these type of crisis increases with capital mobility.

At the same time, the exchange rate policies applied by the Mercosur countries have important differences with the ERM that implied more potential complications for the macroeconomic managment. In the Mercosur case, the systems were implemented in an uncoordinated way. Given the inexistence of a large, low inflationary country inside the Mercosur, the currencies were pegged to the American dollar. The ERM implied a common exchange rate regime for all the participants. The Mercosur stabilisation programs were different in terms of peg hardness and in terms of the period in which they were in operation.

These problems emerged clearly when Brasil decided to abandom the peg in 1999 while Argentina and Uruguay not; a situation that will be analyzed in section 1.4.1.

1.3 Before the crisis. Argentina and Uruguay during the 1990's

In this section the historical background of the crisis is discussed and the similarities and differences between the two countries are highlighted. In particular the similarities and differences in the fiscal and monetary policies followed by Argentina and Uruguay are analyzed.

Argentina and Uruguay experienced during the 1990's an important growth process, as can be seen in Figure 1.1. The Argentine real GDP increased at 5,9% per year from 1991 to 1998, while the Uruguayan one increased at 4.4% per year. Inflation and public debt to GDP ratio decreased during the nineties. Both countries had their currency pegged to the US dollar. At the same time they had an important degree of financial dollarization. With Paraguay and Brazil they participated in the Mercosur integration process. All these aspects are discussed herein.

1.3.1 Monetary and exchange rate policy

The stabilisation plans

Argentina and Uruguay applied during the nineties stabilisation plans with the intention to overcome their inflationary past. Both countries had experienced high

inflation for a prolonged period of time. In order to had a credible nominal anchor these plans implied the management of the exchange rate in order to induce a decrease in inflation. However the systems applied in Argentina and Uruguay had some differences.

The Argentine stabilization plan was in operation from 1991 to 2001, and consisted in a currency board. The exchange rate was fixed by law in 1 Argentinean peso equal 1 US$. The complete monetary base had to be backed up by international reserves of the Central Bank of Argentina. The Uruguayan stabilisation plan was in operation in almost the same period, from 1991 to 2002, and implied a crawling band. At the beginning of the program, the exchange rate of the Uruguayan peso in relation with the US$ was allowed to fluctuate within a band of 7%, the band was devaluated at 2,5% per month.[4]

The fact that the exchange rate regime used in Uruguay was more flexible than the one used in Argentina was motivated by several reasons. In particular it was related to the different inflation rates experimented by both countries before the implementation of the plans. Argentina suffered an important hyperinflation in 1989-90, while Uruguay had a chronic moderate inflation that experimented a peak in 1990.

These plans were successful in reducing the inflation, as can be seen in Figure 1.2. The Argentine inflation was reduced from 2314% in 1990 to 4,2% in 1994. In the case of Uruguay the inflation was diminished from 112,5% in 1990 to 5,7% in 1999. The use of the exchange rate with respect to the dollar as the monetary policy tool implied that the domestic interest rate is endogenous. Another disadvantage is that shocks to the US economy were transmitted to the domestic country. This implied that when the dollar was appreciated with respect to major currencies in the second half of the nineties the same happend to the Argentine and Uruguayan currencies. As was commented in section 1.2.2 it also implied problems to confront external shocks, as the capital flows reversal that these economies suffered at the end of the nineties as will be discussed in section 1.4.

Real exchange rate appreciation

The currencies of Argentina and Uruguay suffered a significant appreciation during this period. This appreciation was related with the important capital inflows from abroad that the Mercosur economies experimented during the 1990s. As Mishkin (1999) states, these capital inflows were encouraged by the lower perceived risk for the foreign investors originated in the more stable value of the currency.

According to Calvo and Talvi (2005) capital flows to the seven largest Latin America economies (including Argentina and Brazil) were minus 13 billion dollars (or minus 1.1 percent of GDP) by the year ending in IV-1989.[5] During the nineties capital flows were increasing and experimented a peak in the year ending in II-1998 when reached 100 billion dollars (or 5.5 percent of GDP).

The existence of indexation mechanisms, developed during the inflationary past, did not allow a quick reduction of the inflation rate and also promoted the appreciation of the real exchange rate.

[4] The width of the band and the month devaluation changed several times, until the peso was allowed to float in 2002.

[5] Capital flows to Latin America countries were very small during the decade of 1980 as a result of the debt crisis of the beginning of this decade.

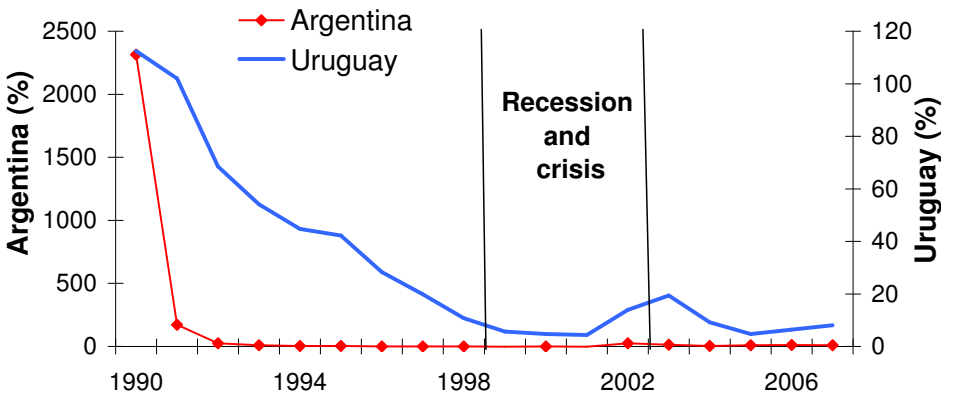


FIGURE 1.2: Argentina and Uruguay: Inflation, 1990-2007

As it is suggested by De Brun and Licandro (2005), the appreciation of the local currencies was promoted by the expansion of private and public consumption, that was encouraged by overoptimistic sentiments about the continuity of the growth process of the 90's.

During the first half of the decade, the real exchange rate with respect to the US suffered an important appreciation, it decreased[6] 50% in the case of Argentina and 42% in the case of Uruguay, from 1990 to 1995. The effective real exchange rate also suffered a strong appreciation during this period.

During the second half of the 1990's, real exchange rate with respect to the US, remained almost constant. However, the value of the dollar was increased relative to the major currencies. As a consequence the currencies of Argentina and Uruguay, also experienced an appreciation process with respect to these currencies.

Although the currencies of Argentina and Uruguay suffered a continuous appreciation during the 1990's, it is not clear that this appreciation represented a process of progressive misalignment of the exchange rate.

According to the evidence reported on Perry and Serven (2003) for Argentina and on Gianelli and Mednik (2006) for the Uruguayan case, the appreciation of the first half of the 1990's seems to be an equilibrium phenomenon. The main determinant of the appreciation of the equilibrium real exchange rate seems to be the increase in productivity[7], that was particularly important in the first half of the nineties in both countries. In the second half of the nineties the equilibrium real exchange rate ceased its appreciation in both countries. However the misalignment of the real exchange rate become a problem after the capital flows reversal in 1998. At that moment Brazil and other trading partners devaluated their currencies, and so the real exchange rate of Argentina and Uruguay become appreciated with respect to these currencies. At the same time the equilibrium real exchange rate started to clearly depreciate (in part following the decrease in productivity that happened at that moment). This progressive misalignment was not possible to correct in the fixed exchange rate regime and was only solved when both countries abandoned their pegs, as it will be analyzed in sections 1.4 and 1.5.

[6] Given the definition of the real exchange rate that we will use throughout this thesis, a decrease implies a real appreciation.

[7] In the literature this phenomenon is known as the 'Balassa-Samuelson' effect

1.3.2 Fiscal policy

Procyclicality of fiscal policies

There exists evidence about weakness in the fiscal policy design in Argentina and Uruguay in the nineties. In particular fiscal policy seems to have been procyclical during that period.

The results of Badagián and Cresta (2005) suggest that fiscal policy did not play a stabilizing role in Argentina and Uruguay. They find evidence of procyclical fiscal policy behavior during the period 1987-2001. Tiscordio and Bucacos (2009) also find evidence of procyclical fiscal policy in the Uruguayan case.

Rial and Vicente (2008) analyze several indicators of fiscal vulnerability during 1976-2006 in Uruguay. They showed that several factors, as the procyclical fiscal policy and the inability to obtain long run financing in local currency, have determined a public debt structure vulnerable to adverse macro-financial shocks.

According to Aboal et al. (2001), the Uruguayan fiscal policy could have had an opportunistic character during 1925-2000. This kind of policy implies that fiscal deficit increases in electoral years and decreases after. This seems to be the case, in the electoral years 1989 and 1994.

As were commented in Section 1.2.2, there are several problems associated to a procyclical fiscal policy. In particular, the economy could be less stable under this kind of fiscal policy, and under a strong pro-cyclical fiscal policy the equilibrium could be not determined.

Fiscal policy was procyclical also during the recession that started and the end of 1998, and culminated in the crisis. As it will be discussed in section 1.4.3 one of the reasons of the procyclical behavior during the recession was the financial restrictions suffered by these countries at that moment. These restrictions were originated in the capital flows reversal and in doubts about the sustainability of fiscal policy. The dynamics of public debt during the nineties is analyzed in next section and after that the issue of the sustainability of the public debt will be discussed.

Public debt dynamics in Argentina and Uruguay

In 1990, the level of public debt over GDP was similar in Argentina and Uruguay, as can be seen in Figure 1.3. According to IADB, at that moment, the Uruguayan public debt was US$ 5.330: (57% of GDP), while the Argentine public debt was US$ 78.889: (56% of GDP).

At the beginning of the nineties, as a result of the Brady agreement the public debt of Argentina and Uruguay were reduced. According to Rial and Vicente (2003) in the Uruguayan case, due to this agreement signed in 1991, the stock of gross public debt was reduced in US$ 634:. In the case of Argentina, Damill, Frenkel, and Rapetti (2005) estimates that the agreement signed in 1992 implied a haircut of US$ 2.323:.

As it is shown in Figure 1.3, during the early nineties the fiscal deficit was low (annual average of 0.2 and 0.5 points of GDP, for Uruguay and Argentina respectively, in 1990-1994). During this period the public debt over GDP ratio decreased. With a dollarized public debt, this fact was mostly related to the increase in the GDP in dollars, induced by real GDP growth and the currency apreciation, which is also shown in Figure 1.3. The real appreciation of the Argentine peso, was more intense than the Uruguayan one, so the decrease of the Argentine public debt over GDP ratio was also more important.

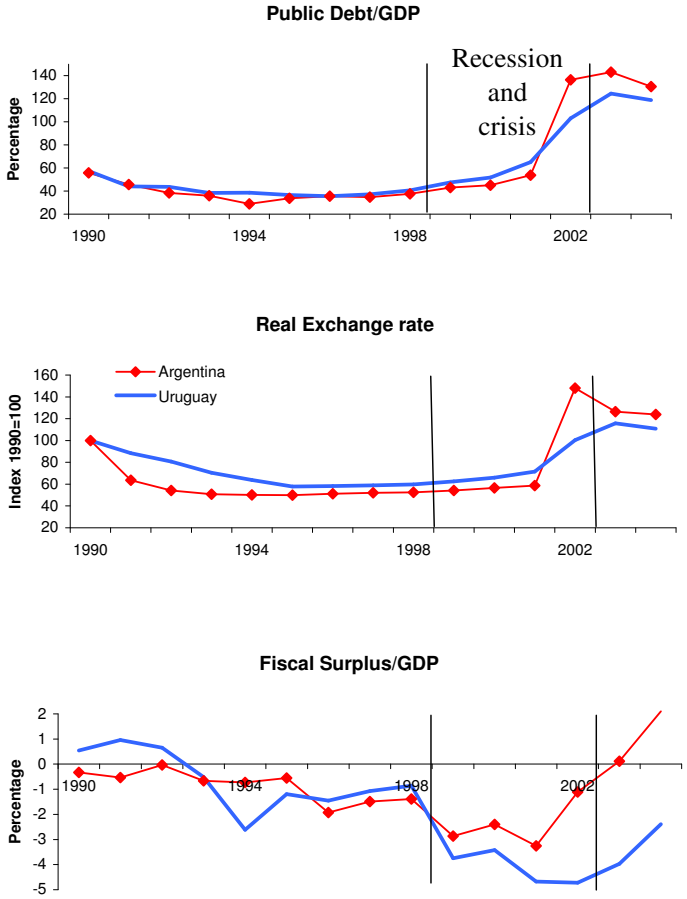


FIGURE 1.3: Argentina and Uruguay: Fiscal indicators and Real Exchange Rate with respect to the US, 1990-2004. Sources: IADB (Debt); INDEC, BCRA, INE, BCU and BLS (RER) and IMF (Fiscal surplus).

In the following years fiscal deficit was increased (annual average of 1,6 and 1,3 points of GDP, for Uruguay and Argentina respectively, in 1995-1997). During this period GDP increased at a slower pace.[8] The real exchange rate with respect to the US did not suffer relevant changes, with a small depreciation in Argentina, and a small appreciation in Uruguay. As a result public debt over GDP suffered a small increase in Argentina and decreased slightly in Uruguay.

The increase in fiscal deficit was partly explained by the implementation of a Social Security Reform in Argentina in 1994 and in Uruguay in 1995. In both cases the social security was transformed from a public pure pay-as-you-go system to a mixed system. The new system combines a public pay-as-you-go part, with a capitalization component that includes private funds. The new system implied a medium term fiscal cost, and a long term improvement in fiscal solvency. For Uruguay, Caristo and Forteza (2003) estimate that the reform caused an initial increase in annual fiscal deficit of 0.6% of GDP, this cost was progressively reduced until 2007 when the reform started to provoke an improvement in fiscal accounts. According to Damill, Frenkel, and Juvenal (2003), in the case of Argentina, the reform triggered an initial rise in annual fiscal deficit of 1.2% of GDP.

[8] In this period Argentina and Uruguay had a short recession in 1995 related to the "tequila" crisis.

In the case of Argentina, during the first half of the nineties several public companies were privatized. The income obtained by these operations was partly used to finance the public budget. In Uruguay, there was also a privatization process, but it was stopped by a referendum in 1992.

In 1997 credit rating agencies gave investment grade status to Uruguayan public debt. Although the rating of Argentine public debt was raised during 1997, it did not reach the investment grade.

The fact that Uruguayan public debt reached the investment grade status but Argentine public debt not, had important consequences in the posterior evolution of the public debt of each country. Argentina had in 1997 a similar public debt to GDP ratio (35% in Argentina versus 37% in Uruguay). The Argentine and Uruguayan public debt increased in the following years, but the different rating implied that each debt had to pay a quite different interest rate.

As we will analyze in Section 1.4, a long lasting recession started in Argentina and Uruguay during the second half of 1998. The beginning of the recession was related to the reversal of capital flows that affected emerging economies at that time. The sudden stop of capital inflows implied an increase in the sovereign spreads of Argentina and Uruguay.

However, during the next three and a half years, the spreads of Argentina and Uruguay were quite different. The average Argentine EMBI[9] and the average Uruguayan UBI[10] were 9,5% and 2,2% during the same period.

The Uruguayan spread only suffered a sharp increase after public debt lost the investment grade status in February 2002. These different credit conditions had an important influence in the public debt dynamics throughout the recession and in the resolution of the severe public debt problems that both countries suffered during the crisis.

Fiscal sustainability in Argentina and Uruguay

Given the dollarization of the public debt, the movements in the ratio public debt over GDP were explained by the important swings in the real exchange rate (and to a lesser extent by the GDP movements), as can be seen in Figure 1.3. The relation between the evolution of the public debt and the fiscal deficit process was less clear. In particular it is not obvious if the fiscal deficits of the pre-crisis period necessarily led to an explosive public debt dynamics (i.e. it is not clear if fiscal policy was sustainable).

In order to discuss this question, appendix 1.7.3 test the sustainability of the Argentine and Uruguayan fiscal policies. This analysis can shed light on two different questions. Firstly it can help to assess the origins of the public debt problems: lack of fiscal sustainability or the occurrence of self-fulfilling speculative attacks.[11] Secondly it can help to elucidate if Argentina and Uruguay were different in terms of fiscal sustainability.

In appendix 1.7.2 a theoretical condition for fiscal sustainability is developed following the analysis of Quintos (1995). This condition implies testing if revenues

[9] EMBI ("Emerging market bond index"), elaborated by JP Morgan, corresponds to the sovereign spread (% over US government bonds yield, considered risk free, that have to pay public bonds).

[10] UBI ("Uruguay Bond Index"), elaborated by Republica AFAP with a similar methodology than EMBI. For Uruguay we use UBI instead of EMBI because the information about Uruguayan EMBI starts in 1999.

[11] Theoretically, the government could also take the decision to default without any solvency or liquidity problem. This kind of default is emphasized in the literature on sovereign debt with strategic default initiated with the seminal work of Eaton and Gersovitz (1981)

and expenditures including interest payments are cointegrated, provided that they are I(1) processes. After that, appendix 1.7.3 tests this condition for Argentina and Uruguay.

Specifically cointegration on the following regression equation is tested:

$$R_t = \mu + bG_t^r + \epsilon_t \tag{1.1}$$

where R_t is tax revenues, and $G_t^r = G_t + r_t B_{t-1}$ is government expenditures including interest payments.

The empirical strategy involves testing cointegration in equation 1.1 and additionally testing the value of b. If it cannot be rejected the hypothesis of b=0, fiscal policy is considered non-sustainable. If there is no cointegration but $0 < b \leq 1$, fiscal policy is considered sustainable in a weak sense. Fiscal policy is also considered weak-sustainable if there is cointegration and $0 < b < 1$. Finally, fiscal policy is strong sustainable if there is cointegration and b=1. These criteria are summarized in Table 1.3 in appendix 1.7.2.

According to this exercise the hypothesis of no cointegration is rejected in the Argentine case. The null hypotesis of b=0 and the null of b=1 are also rejected. The estimated b is 0.60. Fiscal policy was sustainable only in a "weak sense" in Argentina during this period.[12]

TABLE 1.1: Cointegration test

	Cointegration	Coef b-Test	Fiscal Sust
Argentina	Yes	0<b<1	Weak
Uruguay	No	b=1	Weak

In the Uruguayan case the hypothesis of no cointegration cannot be rejected. The estimated b is higher than the corresponding to Argentina (0,8), and the null hypotesis of b=1 cannot be rejected. According to the criteria that were commented, fiscal policy is considered weak sustainable, also in the Uruguayan case in the pre-crisis period.

The previous analysis suggest that fiscal policy was sustainable in a weak sense in Argentina and Uruguay. There is no clear evidence that Argentina and Uruguay were different in terms of fiscal sustainability during the pre-crisis period.

The debt process is sustainable under the weaker condition, but the absence of strong fiscal sustainability implies that the public debt growth is a non stationary process.[13] This makes the debt process more sensible to shocks.

With a dollarized public debt, a devaluation implies a shock that increases the weight of the public debt. Without strong fiscal sustainability this can have a high and durable effect on the debt process, as happened in Argentina and Uruguay after the abandonment of the peg.

As it is discussed in Appendix 1.7.3, under the weaker condition, a sudden stop shock combined with a persistent recession could push debt into an unsustainable path.

[12] For more details about this excercise in the Argentine and the Uruguayan case see Appendix 1.7.3.

[13] See equation 1.7 in Appendix 1.7.2

These results are consistent with the results of Aráoz et al. (2007) for the Argentine case. The results are also consistent in the Uruguayan case with the analysis of De Brun and Licandro (2005), although they used a different methodology. In their study they find evidence of over accumulation of public debt (with respect to a fiscal rule that ensures fiscal balance over the business cycle), in Uruguay between 1993-2001.

The previous analysis have also some drawbacks. In particular this type of analysis was developed to study the sustainability of US fiscal policy. The idea was to evaluate if the increase of US fiscal deficit could finish in a default or not. However in the case of a country that already had a default this kind of analysis has less sense.

This is particularly true in the case of Argentina after the default. A primary analysis suggests that the sustainability of fiscal policy was increased if we considered also the years after 2001. However, this increase in the sustainability was obtained by assuming that fiscal policy was unsustainable (via default).

Finally the previous exercise does not provide clear evidence about a different fiscal sustainability behavior in Argentina and Uruguay. The different credit conditions seem to be originated in another type of considerations.

Differences in reputation

As was commented in Section 1.3.2, in 1997 credit rating agencies gave investment grade status to Uruguayan public debt, a status that Argentine public debt did not reach. This fact had important consequences in the posterior public debt dynamics of both countries. However the previous results do not support the idea that the different credit conditions were originated in a clear different behavior in terms of fiscal sustainability.

TABLE 1.2: Argentina and Uruguay in 1997

	Argentina	Uruguay
GDP per capita (US$)	8.210	6.667
Inflation (CPI, % change Dec/Dec)	0,3	15,2
Gen.Gov.Financial Balance/GDP	-1,5	-2,1
External Vulnerability Indicator	190	433
External Debt/CA Receipts	345,9	189,5
Government Effectiveness [1]	0,2	0,7

Source: Moody´s (2007).
Notes: [1] Corresponds to year 1998.

In table 1.2 we can see data of Uruguay and Argentina in 1997, according to Moody´s (2007). The selected data represent the main variables that explain the qualification given by the rating agencies according to Pena (2002). Argentina had at that time an equal or better performance than Uruguay in terms of GDP per capita, inflation rate, fiscal balance and external vulnerability. However its performance was worse in terms of external debt over Current Account receipts (Argentina is a more closed economy), and Government Effectiveness. The latter fact reflects the bad reputation of Argentine institutions, and in particular its bad reputation as debtor.

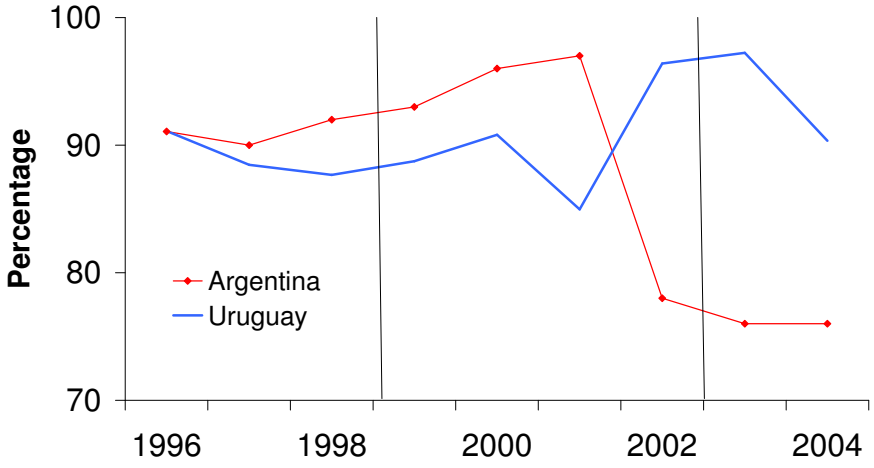


FIGURE 1.4: Argentina and Uruguay: Public debt in foreign currency, 1996-2004. Source: IADB

The different credit conditions had important consequences in the posterior public debt dynamics of both countries. The ratio public debt over GDP suffered a big jump after the abandonment of the peg in both countries. However, the interest rate of the Argentine public debt was very high at that moment. On the contrary the interest rate of the Uruguayan public debt was relatively small, given that the majority of the debt was issued under the "investment grade" status. This situation favored the tough approach followed by Argentina to solve its public debt problems, that included a default and an unprecedent haircut in the posterior swap. However, this approach is likely to deep the Argentine reputational problems, implying a sort of "vicious circle". This topic will be discussed again in Section 1.5.4.

1.3.3 Financial vulnerabilities in Argentina and Uruguay

Currency substitution

During this period Argentina and Uruguay were highly de facto dollarized. A great part of the deposits and credits in the banking sector were in foreign currency. The public debt was also in a great extent dollarized, as can be seen in Figure 1.4.

The currency substitution phenomenon is primarily a response of the agents to an inflationary environment. As the inflation erodes the store of value quality of the domestic currency, agents switch to the foreign currency in order to avoid this outcome. However, once the currency substitution acquires an important dimension, the process shows a great persistence even after the inflation is reduced to low levels.

As Licandro and Licandro (2003) argue, a high degree of currency substitution imposes several limitations on the monetary policy. The interest rate channel and the credit channel of the monetary policy do not work as usually. As the credit is dollarized both channels work through the exchange rate. With a high degree of dollarization of assets and debts, the relevant interest rate for the decisions about investment and consumption is the dollar interest rate that is not under the control of the Central Bank.

Although inflation was decreasing during the 1990's, and both countries had one-digit inflation at the end of decade, there is no evidence of a decrease in the degree of the facto dollarization. The participation of the credits in dollars in the banking credit to the private sector increased during the pre-crisis period, as it will

be discussed in Section 1.4.4. The percentage of public debt in foreign currency were also increasing during this period, as it is shown in Figure 1.4.

Banking regulation did not emphasize in preventing currency mismatches. This problem can be related to the fixed exchange rate regime as was commented in section 1.2.2.

Other related vulnerabilities

The important degree of dollarization was combined in the Argentine case with at least two other vulnerabilities that affected the financial system, that are emphasized by Setser et al. (2005). First of all private debt in dolares was very big compared with exports. According to Setser et al. (2005) at the end of 2000, Argentine firms had borrowed US$ 67 billion in dollars (37 billion externally and US$ 30 billion in foreign currency from the domestic banking system). On the other hand, Argentine annual exports amounted to only US$ 31 billion, which implied difficulties for Argentine firms to hedge against exchange rate shocks.

Another vulnerability was related to the composition of the assets of the banking sector and in particular to the important participation of public debt in these assets. At the end of 2000, 28% of the assets of the Argentine banking system was consitituted by loans to and securities issued by the public sector (the majority of these credits were in dollars). By this way the soundness of the banking system was linked to the strength of fiscal accounts.

In the Uruguayan case, these vulnerabilities were not so compelling. In particular, credit to public sector was approximately 5% of banking system assets in 2001. However, as it is noted by De Brun and Licandro (2005), the health of the Uruguayan fiscal accounts was linked to the banking sector by several ways. The state owned Banco Hipotecario del Uruguay (BHU) accepted deposits in dollars and gave loans in UR (Unidades Reajustables, a wage index unit). This currency mismatch exposed the BHU to an important currency risk. In the case of the private banking sector, although in their balance the currency mismatch was less important, they were lending in dollars to agents with income in pesos, so they were indirectly exposed to an important currency risk. The existence of an implicit deposit insurance, implies a contingent liability for the pubic sector associated to the financial fragility of the banking system.

1.3.4 A decade of regional integration and growth

During the nineties Argentina and Uruguay participated in the Mercosur integration process. The Mercosur was established on 26 March 1991 with the signature of the Asunción Treaty by the Presidents of Argentina, Brazil, Paraguay and Uruguay. This treaty included a Program of Trade Liberalization with the objective of eliminating all tariffs within Mercosur by 31 December 1994. However, several items were excepted from the reduction. In 1994, the Protocol of Ouro Preto deepened the integration process by the introduction of a common external tariff ranging from 0 to 20%.

The interregional trade was fostered by the signature of the Asunción Treaty. In 1990 the trade among the Mercosur members was US$ 4,1 billion (9% of Mercosur total exports), in 1998 this trade amounted to US$ 20,4 billion (25% of Mercosur total exports). The growth of the interregional exports coincided with a period of expansion of the external trade of the Mercosur economies. The Argentine exports increased from US$ 12,3 billion in 1990 (14,8% destined for Mercosur) to US$ 26,4

billion in 1998 (35,6% destined for the region). In the case of Uruguay, its exports were incremented from US$ 1,7 billion in 1990 (34,8% destined for Mercosur) to US$ 2,8 billion in 1998 (55,3% destined for the region).

The economies of Argentina and Uruguay experienced during this period an important economic growth, as was commented at the beginning of section 1.3 (5,9% and 4.4% real GDP growth per year from 1991 to 1998, in Argentina and Uruguay respectively). The economies of Brazil and Paraguay also enjoyed a period of growth but at a slower pace (2,7% and 2,4% per year, respectively).

Given its size, the Mercosur process is very much influenced by the behavior of Brazil. The Brazilian GDP represented 68% of the Mercosur GDP in the period 1991-2002.

The intention of reaching some coordination of the macroeconomic policies was present in the original Asuncion Treaty.[14] However, the first clear proposal for exchange rate coordination was made by Brazil in 1993. This proposal implied a similar mechanism to the ERM applied in Europe but searching the stability of the bilateral real exchange rates. Argentina considered that the plan should be based in the nominal exchange rates and that it should include a more general stabilization framework. There were also some suggestions about the convenience of a monetary union, for example this idea was mentioned by the Argentine president Menem in 1997 as one objective of the Argentine Presidency of MERCOSUR.

During 1994 an exchange rate based stabilisation plan, similar to those in force in Argentina and Uruguay, started in Brazil. This plan (called the "Real Plan") was in operation from 1994 to 1998. Initially, the intention was to implement a fixed exchange rate with a 1:1 parity with the US$, but later, in order to avoid an excessive appreciation of the Real, a band with regular mini devaluations was established. As in the case of Argentina and Uruguay, the plan was successful in reducing the inflation, that was decreased from 2076% in 1994 to 3,2% in 1998.

As it is suggested by Rozemberg and Svarzman (2002), although there were no advances in a formal exchange rate coordination, the beginning of the stabilization plan in Brazil implied that Argentina, Brazil and Uruguay had an exchange rate peg with the dollar and implicitly a stable exchange rate between them.[15] This generated some enthusiasm with the integration process that contributed to the signature of the, already mentioned, Ouro Preto Protocol that deppened the Mercosur agreement.

As was commented in section 1.2.3, this informal exchange rate coordination implied a sort of incomplete monetary union, a system prone to credibility problems. These problems where at the center of the stage when, in the middle of speculative attacks, Brasil decided to abandom the peg, as it will be discussed in section 1.4.1.

As was discussed in Section 1.3.1, the currencies of Argentina and Uruguay experienced an important appreciation during this period. This fact and the output increase, motivated an increase in imports even more important than the one of the exports. According to the evidence reported in IMF (2003), when trade liberalization is combined with real exchang rate depreciation the result is a strong export performance. In Argentina and Uruguay, given the currency appreciation the trade liberalization was accompanied with negative net exports and current account deficits. These current account deficits were financed by capital inflows.

[14] See for example the discussion about this topic in Kronberger (2004)

[15] Remember that Argentina and Uruguay had in application stabilization plans based in a peg with dollar from 1991.

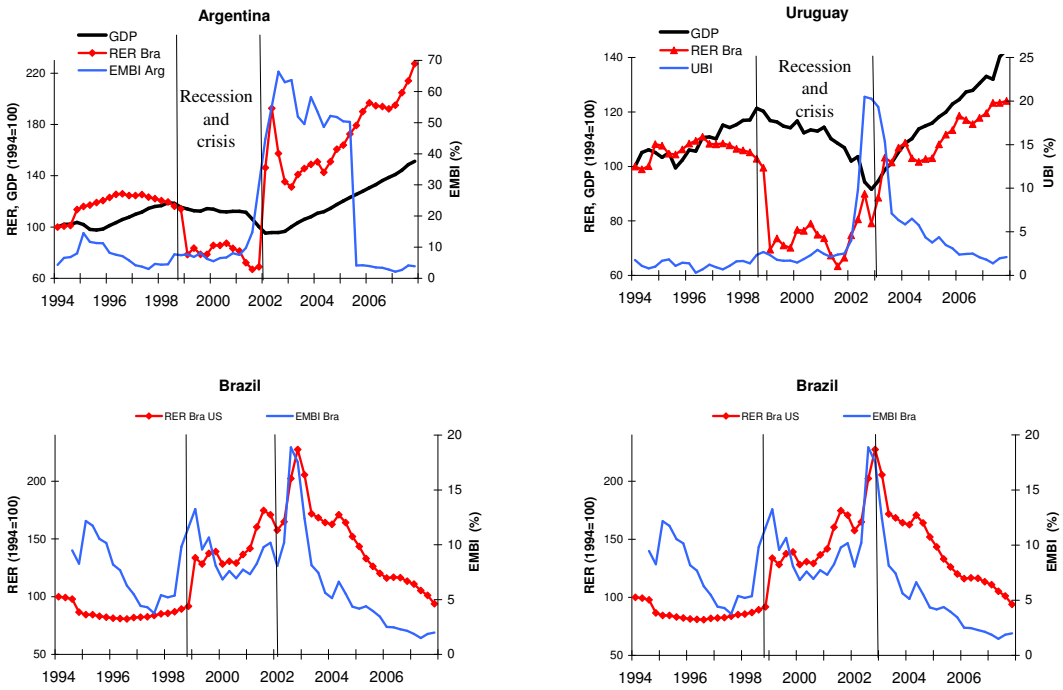


FIGURE 1.5: Argentina, Uruguay and Brazil: GDP, Real Exchange Rate and Sovereign Spread, 1994-2007

1.4 The crisis

1.4.1 The beginning of the recession

During the second half of 1998 recession started in Argentina and Uruguay. As can be seen in Figure 1.5, the GDP decline was highly persistent in both countries and was reverted only during 2002 in Argentina and during 2003 in Uruguay.

The capital flows reversal

The beginning of the recession was related to a deterioration in the external conditions. The Russian default of August 1998 led to a sudden stop in capital inflows to emerging economies and Latin America economies in particular. According to Calvo and Talvi (2005) capital flows to the seven largest Latin America economies (including Argentina and Brazil) were 100 billons dollars (5,5% of GDP) in the year ending in the second quarter of 1998 but decreased to 37 billons dollars (1,9% of GDP) one year later. Interest rates suffered a sharp increase in emerging economies. The sovereign spread in emerging economies was doubled, EMBI was 5,2% in the first half of 1998 and jumped to 11% in the second half of the year.

As can be seen in the lower part of Figure 1.5 Brazil suffered an increase in country risk in line with the rest of emerging economies. Brazilian EMBI was 5,3% during the first half of 1998 and 10,7% during the second.

The sovereign risk of Argentina and Uruguay, also shown in the upper part of Figure 1.5, increased as well. Paradoxically the raise was a bit lower than the average increase in emerging economies. Argentine EMBI was 4,4% during the first half of 1998 and jumped to 7,6% during the second half. In the case of Uruguay UBI rose from 1,5% to 2,5% in the same period.

The impact of this shock in Argentina and Uruguay was more persistent than in other emerging economies due to local vulnerabilities. In particular, the shock was

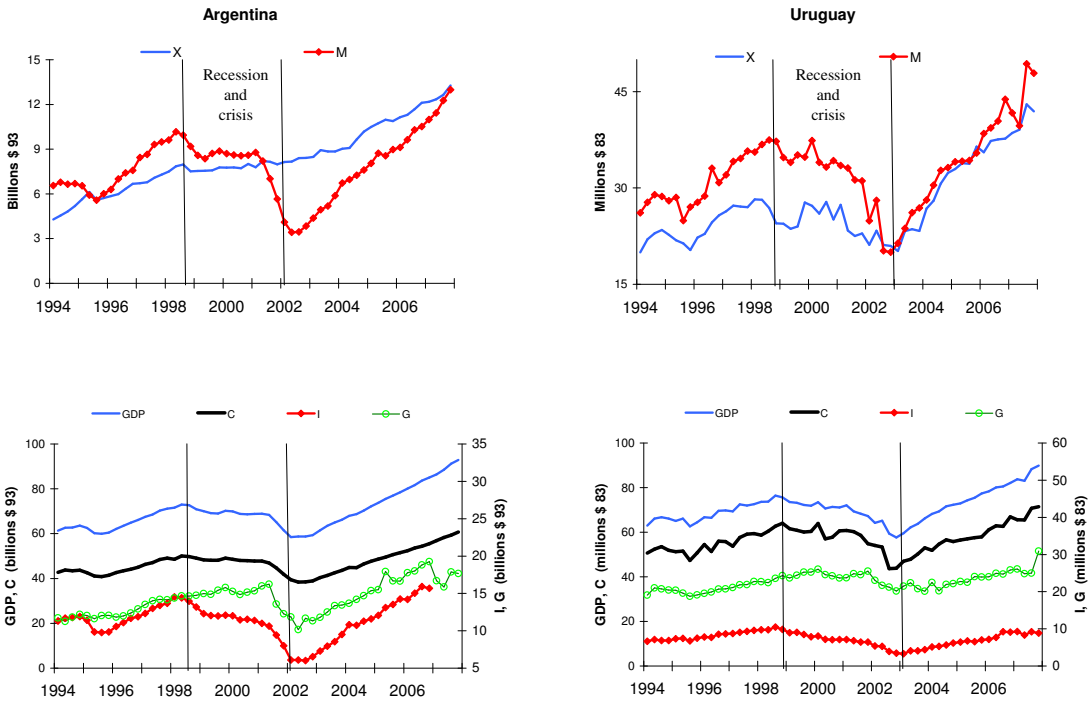


FIGURE 1.6: Argentina and Uruguay: GDP and GDP components, 1994-2007

amplified by the different exchange rate policies followed by other Latin America economies.

The Brazilian devaluation

After the sudden stop the currencies of many emerging economies suffered an important depreciation. This was not the situation of Argentina and Uruguay that decided to maintain their pegs. The decision was related to the high degree of financial dollarization that suffered both countries. As we discussed in Section 1.2.1, 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). Fears of returning to previous high inflations could also have played in the decision. However, Brazil, the main trading partner of Argentina and Uruguay, took another option.

The Brazilian economy suffered important fiscal and external problems that were aggravated after the Russian default and there were doubts about the continuity of the exchange rate regime. Brazil experimented a great loss of reserves. In January 1999, the governor of one of the states of Brazil declared a moratorium on the state debt that reinforced the speculative attacks.

Finally, 10 days after the declaration of moratorium, the Real Plan[16] was abandoned and an important fiscal adjustment was implemented. Financial dollarization was less important in the Brazilian case so the negative balance sheet effects were less relevant. The devaluation alleviated the external problems of the Brazilian economy, the GDP continued increasing and the economy did not return to its inflationary past.

[16] See section 1.3.4 for details about the Real Plan.

1.4.2 Activity drop

The Brazilian exchange rate suffered a sharp adjustment after the flotation of the Real. The exchange rate was 1,2 reals per dollar in December 1998, and jumped to 1,9 reals per dollar in February. This change implied also an important real depreciation for Brazil. As we can see in the lower part of Figure 1.5, the Brazilian bilateral real exchange rate with respect to the US increased 46% from the last quarter of 1998 to the first quarter of 1999.

The depreciation of the Brazilian currency implied an important appreciation for the currencies of Argentina and Uruguay, as we can see in the upper part of Figure 1.5. During 1999 the bilateral real exchange rate with respect to Brazil was appreciated 32,1% in the Argentine case, and 31,2% in the Uruguayan case. The effective real exchange rate, shown in Figure 1.7, was also appreciated, 5,3% in Argentina, and 4,8% in Uruguay.

At that time the Brazilian economy was very important for Argentina and Uruguay, and the devaluation of the real aggravated their external problems. According to the, already commented, works of Perry and Serven (2003) and Gianelli and Mednik (2006), the real exchange rate of Argentina and Uruguay was appreciated with respect to its equilibrium value during 1999. This overvaluation remained until the end of the peg.

The Argentine exports to Brazil were US$ 8.133 million in 1997 (30,8% of total exports) and were diminished to US$ 5.690 million in 1999 (24,4% of total exports). The Uruguayan exports to Brazil were US$ 894 million in 1997 (34,4% of total exports) and were reduced to US$ 557 million in 1999 (24,9% of total exports).

The drop of the Brazilian demand was not easy to substitute for other external customers, given the type of products and services involved, and given that the Mercosur currencies were appreciated with respect to the rest of the world. This situation aggravated the recessive effects of the sudden stop.

The behavior of the GDP components is shown in Figure 1.6. As we can see, internal components of aggregate demand decreased. The decrease was particularly intense in the case of investment, affected by the drop in available external financing. Although imports also decreased at the beginning of the recession, the adjustment of the Current Account was only possible after the abandonment of the peg and the abrupt adjustment of the real exchange rate as we can see in Figure 1.7.

1.4.3 Exchange rate and fiscal policies

The maintaining of the peg with respect to the dollar implied that the adjustment of the real exchange rate, required by the sudden stop, was very gradual. In the Argentine case, the lack of adjustment of the exchange rate called for an adjustment in internal prices, that had to evolve below the international prices. In Uruguay we had a similar situation but less dramatic considering the more flexible regime in force. Given price rigidity this type of adjustment was accompanied by a long recession.

After the Russian default and the capital flows reversal, this type of adjustment allowed a gradual depreciation of the real exchange rate with respect to the US, as we can see in Figure 1.7. However the different exchange rate behavior of other trading partners, notably Brazil, implied that the effective real exchange rate was appreciated in 1999, as was already commented.

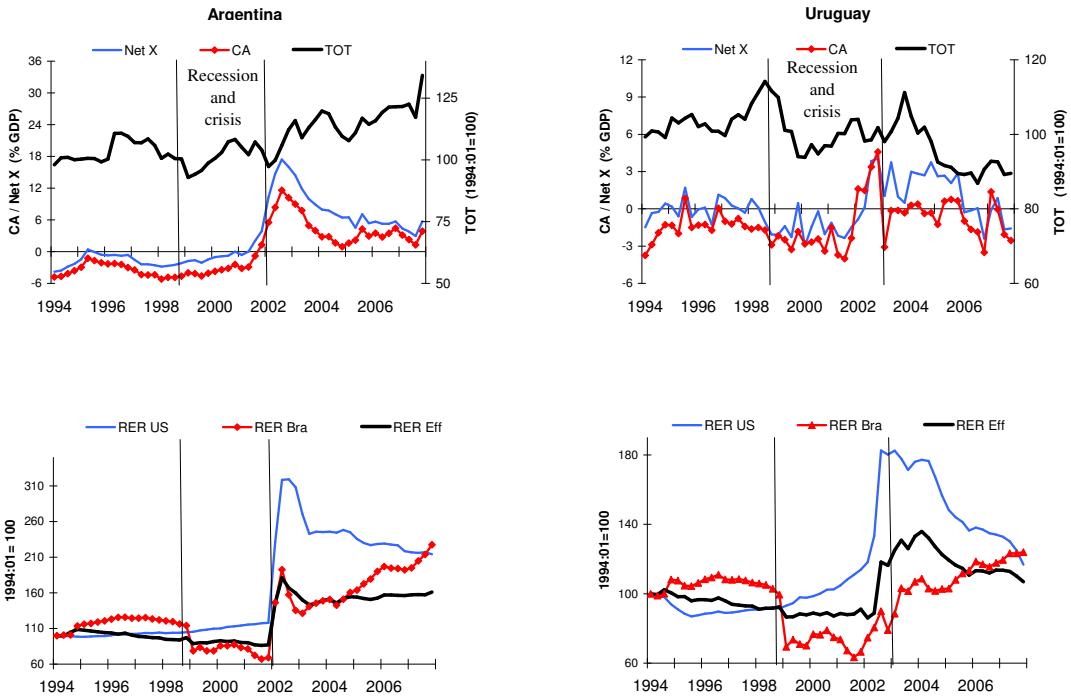


FIGURE 1.7: Argentina and Uruguay: Net Exports, Current Account, Terms of Trade and Real Exchange Rate, 1994-2007

After the Brazilian devaluation of January 1999, the Uruguayan authorities decided to postpone a preannounced reduction in the rate of the crawling band, trying to facilitate the adjustment in the relative prices.

During 2000 the effective real exchange rate was depreciated 1% in Uruguay and 2% in Argentina.

During 2001 the Brazilian currency suffered a new real depreciation, as we can see in Figure 1.5. This provoked a new appreciation of 4,7% of the Argentine effective real exchange rate. In Uruguay, in mid 2001 the rate of the crawling band and the width of the band was multiplied by two (the width was fixed in 6% and the rate in 1,2% per month). This helped to confront with the new Brazilian depreciation, and the Uruguayan effective real exchange rate was depreciated 0,8% during 2001.

In the last quarter of 2001, 3 years and a half after the Russian default, the Uruguayan effective real exchange rate was almost at the same value of 1998. At the same moment, Argentine effective real exchange rate was 8,5% appreciated with respect to 1998. In 2001, the deviation of the actual Argentine real exchange rate from its equilibrium value was estimated in 53% by Perry and Serven (2003). As we will see in Section 1.5 Convertibility was abandoned at the beginning of 2002, and Uruguay abandoned its peg in mid 2002.

The financial restrictions and the idea that a tight fiscal behavior could restore confidence motivated that fiscal policy was mostly oriented in a contractive way.

In the Argentine case, where the financial restriction was more intense, this orientation was more clear. During 1999, that was an electoral year, no cut in real primary expenditures were implemented. However, total expenditures rose given that interest expenses had an important increase. On the contrary, public revenues decreased due to the recession. As a result fiscal deficit increased from 1,4% of GDP during 1998 to 2,9% in 1999.

At the end of 1999, the Argentine Parliament approved the "Fiscal Responsibility Law". The norm included the creation of a "Countercyclical Fiscal Fund" that

consisted in the obligation for the government to accumulate resources until the Fund reached 3% of GDP, the resources would be used when a "reversion in the economic cycle" took place. Indeed the economy was already in recession and the Fund never materialized.[17] The law also 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 during that year all the components of primary public spending were reduced. The fall was specially strong in the case of public investment. However, the decrease in total expenditure was minor given the permanent increase in interest expenses. Several taxes were increased during 2000 and government revenues increased, despite the recession. The fiscal deficit was reduced 0.5% of GDP up to 2,4%.

The declared objective of these measures was to restore the confidence in Argentine macroeconomic policy. Nevertheless, sovereign spread remained during 1999-2000 at the high levels attained after the sudden stop of mid 1998. During 2001 the spread started to increase again very fast pushing public debt into an unsustainable dynamics, as we will discuss in Section 1.5.

In Uruguay, during the electoral year of 1999 no contractionary measure was taken. Instead, public investment was increased. Additionally, recession provoked a decrease in tax collection, and social security expenditures were increased in part explained by the rise in the payments of unemployment benefits. Fiscal deficit increased from 0,9% of GDP during 1998 to 3,7% in 1999. During 2000 and 2001, public investment was reduced, but the decrease in tax collection and the increase in interest expenses implied that fiscal deficit was kept at a high level.

Despite the fiscal deficit and the recession, credit rating agencies kept the rating of Uruguayan public debt. Sovereign spread decreased during 1999 and remained at low levels until February 2002 when the debt lost its investment grade status.

1.4.4 Financial deterioration

The slow type of adjustment followed by Argentina and Uruguay after the sudden stop, did not help to reduce the exchange rate risk exposure of debtors. As we can see in Figure 1.8, the proportion of credits in dollars in the banking system increased during the recession. This fact was favored by the lack of a regulation that discouraged non tradable agents from taking credits in dollars. This absence of anti-dollarization regulation was consistent with the exchange rate regime, specially in the Argentine case. Given that the peso-dollar relation was fixed by law, it was no clear why regulation had to stablish limits on currency mismatches.

As can be seen in Figure 1.7 the behavior after the sudden stop of the real exchange rate with respect to the US and the effective real exchange rate was different . The real exchange rate with respect to the US was gradually depreciated during the recession. This implied some small negative balance sheet effects, added to the recession, that affected public finances and the banking sector.[18]

The recession combined with increasing de facto dollarization and gradual depreciation of the real exchange rate with respect to the US affected the financial system solvency. As we can see in Figure 1.8 the problems to recover credits were

[17] For a more detailed description of the discussion and execution of the Fiscal Responsability Law see Gadano (2003)

[18] For agents with debts in dollars and assets in pesos, the relevant real exchange rate is the one with respect to the US.

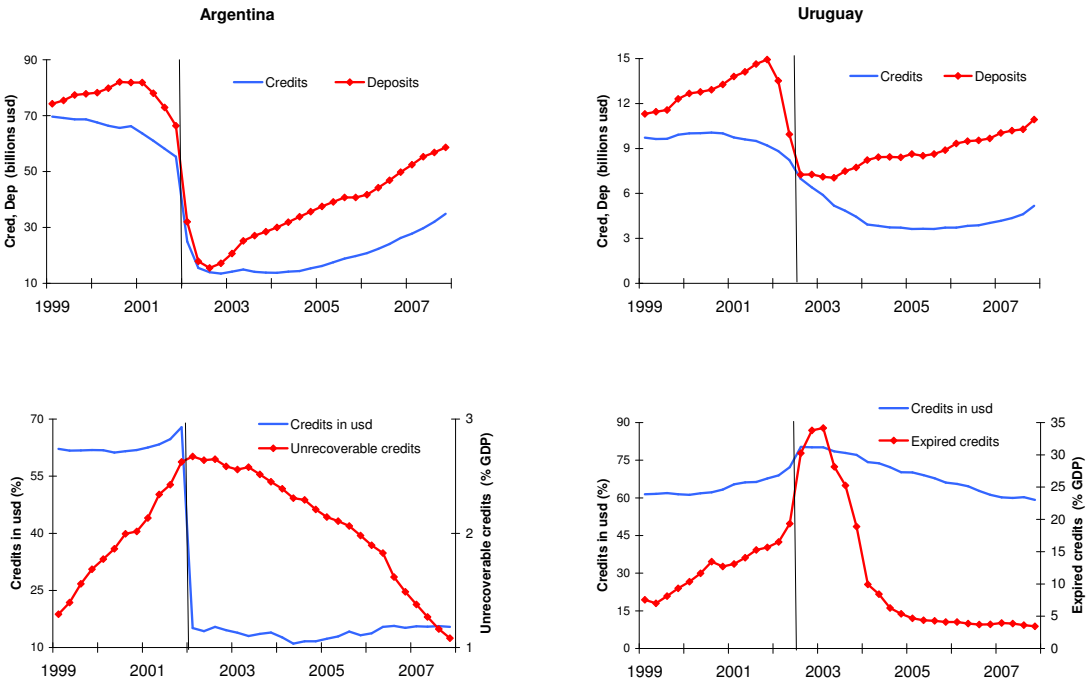


FIGURE 1.8: Argentina and Uruguay: Credits and Deposits in the banking system, 1999-2007. Vertical line represents the end of peg.

increasing during the recession in both countries.[19] Deposits in the banking system increased during the recession, and liquidity problems only arose during 2001 in Argentina and in 2002 in Uruguay. The financial situation of the public sector was also damaged by the decrease in tax collection associated to the recession, and the increase in interest expenses of the dollarized public debt.

1.5 Collapse and Recovery

1.5.1 The final stage

The end of the convertibility

The left panel of Figure 1.9 displays the evolution of some Argentine financial variables during 2001 and the first half of 2002. As we can see in the Figure, the final phase of the Argentine crisis was marked by a triple run (against banking deposits, public debt and currency) that provoked a decrease of 20% of the level of reserves.

During that period many attempts were made to restore confidence. At the end of 2000 an important package of 40 billion dollars of financial support leaded by the IMF was announced, (the plan was called "blindaje"). The plan attempted to alleviate the short run financial constraint, giving time to execute measures that improved the fiscal sustainability in the long run. The beneficial effect of the plan on the expectations was modest and after a few months, country risk started to rise again.

[19] Due to data limitations we cannot show the same variable for the two countries. Although the definitions of unrecoverable credits and expired credits are not the same, both clearly show the increase in the difficulties to recover credits in the banking system.

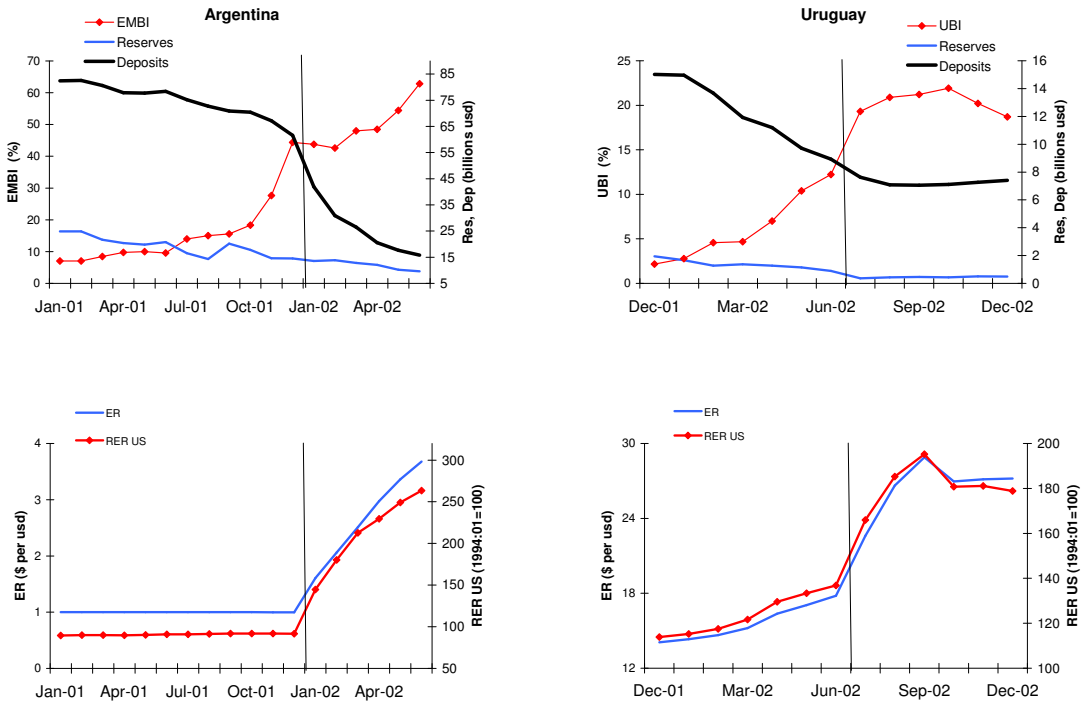


FIGURE 1.9: Financial indicators in Argentina (Jan 2001-Jun 2002) and Uruguay (Dec 2001-Dec 2002). Vertical line represents the end of peg.

In May 2001 a voluntary debt swap (the "megacanje") was put into operation. According to Mussa (2002), as a result of the "megacanje" debt service was diminished by 12 billion dollars in 2001-2005, but given the high interest rate of the new issued debt (between 15% and 16%), debt service was increased by 66 billion dollars after 2005. The high interest rate accepted by the Argentine government for the operation, reinforced the vision that the public debt was unsustainable.

In mid 2001 a more severe "zero deficit" fiscal policy was put into practice. This policy implied a 13% cut in public wages and pension benefits, and reductions in public investment. The effects of this policy were different from what the authorities had expected. The same day that Minister Cavallo announced this policy (15/07/2001), Argentine EMBI rose from 1200 to 1600 basis points.[20]

In November 2001 another swap, was executed for about 42 billion dollars. In this swap participated bonds in power of local creditors (mostly banks and pension funds) that were changed for loans with lower yield but guaranteed with taxes.

In the banking sector the withdrawal of deposits that started by the end of 2000, was intensified during 2001, as can be seen in Figure 1.9, with some small pauses related to the implementation of the "blindaje" and the "megacanje".

As we can see in Figure 1.9, EMBI was growing during 2001, and passed the barrier of 10% in June 2001. According to Mussa (2002) IMF staff estimations in 2000 suggested that with a sovereign spread of 10% or more it was unlikely that Argentina would have been able to grow, given the implied high interest rates. Also with this level of spread the primary budget surplus necessary to stabilise public debt was so high that default could have been unavoidable. During the second half of 2001 spread continued growing very fastly. At the begining of December 2001, the spread was 40%.

[20] To see different explanations about this striking fact, see Powell (2002) or Hausmann and Velasco (2002).

As we commented during 2001 Argentine real exchange rate was again appreciated as a result of a new Brazilian depreciation, and became strongly misaligned.

The combination of increasing interest rates, new currency appreciation, contractionary fiscal policy and increasing credit crunch,[21] led to a strong GDP decrease during the second half of 2001. Seasonal adjusted GDP decreased 7,5% in the second half of 2001 with respect to the first half of the year. This drop in GDP was added to the persistent GDP decrease of the previous 3 years. Unemployment rate, that was 13,2% during 1998, attained 18,3% during the second half of 2001.

Finally, in December 2001, the government imposed several restrictions on cash retirements (the "corralito"). These measures were highly unpopular and were added to the strong social discontent associated with the long lasting recession and the high and increasing unemployment rates.

After some days of strong anti-government demonstrations, that included episodes of looted stores, bank attacks, and almost 30 deaths in confrontations with the police, the government resigned.

Several provisional and short-lived governments took office during the following days. During this period the government decided a default on the public debt, the convertibility was abandoned and a free floating regime for the peso was initially adopted. The foreign currency deposits in the banking sector were compulsory transformed into peso deposits at an exchange rate of 1,4 pesos per dollar and their maturity was extended, the credits in dollars were transformed into peso credits at a rate of 1 peso per dollar (the "asymmetric pesification"). Some months after these measures Argentine GDP started to grow again.

The end of the Uruguayan peg

As we can see in Figure 1.9 the Argentine exchange rate was multiplied by four in the months following the convertibility collapse. This implied a sharp depreciation of the Argentine real exchange rate. For Uruguay, whose economy was closely connected to Argentina, the convertibility collapse represented an important appreciation of its effective real exchange rate. As a result, the Uruguayan real exchange rate was strongly misaligned during the first half of 2002, according to Gianelli and Mednik (2006).

Trying to confront with this new shock, the rate of devaluation and the width of the band were doubled again, in January 2002. Moreover, a fiscal adjustment plan was sent to the Congress.

The Uruguayan banking sector had important linkages with Argentina. In particular, an important part of the deposits of Argentines were made in the Uruguayan banking system given its better reputation with respect to the Argentine one. After the "corralito" was implemented in Argentina, Argentines started to make important withdrawals from the Uruguayan branch of "Banco de Galicia", an Argentine bank that was suspected of lack of solvency. In January 2002, the Vice-President and the General Manager of the Banco Comercial, the most important private bank of Uruguay, resigned to their position. These managers, were accused of fraudulent practices in Argentina where they also managed an important financial institution. Banco Comercial suffered important withdrawals during this period. Banco de Galicia was suspended by the Central Bank of Uruguay on February 13. One

[21] According to the private banks statements of source and application of funds, published by the Central Bank of Argentina, during 2001 deposits repayments become the main application of the banks funds while the recover of credits became the main source. This fact reflects the financial disintermediation process suffered by Argentina during 2001.

day after, Standard & Poor's decided to take away the investment grade status of the Uruguayan public debt. As can be seen in the right panel of Figure 1.9 in the following months the run against the banking sector and the public debt became intense. As a result, foreign exchange reserves in Central Bank decreased during 2002.[22] In June 2002, when the government allowed the flotation of the peso, reserves were more than 50% lower than in December 2001.

Trying to restore confidence, Banco Comercial was capitalized by the government and the owner institutions. By the end of February the Parliament approved a fiscal adjustment law, including new taxes. In March, a new stand-by agreement with the IMF was signed. However the run against the banking sector and the public debt continued after these measures.

By the end of May an augmentation of the program with the IMF was announced. As we commented, the Uruguayan peso was allowed to float in June.

Nevertheless, the run in the banking sector was accelerated until July 30, when a banking holiday was decreed. The insolvent banks were suspended. On August 4, the Parliament approved a Law creating a Fund for Stability of the Banking System (FSBS) of 1.5 billion of dollars, financed by international financial institutions (loans of the IMF, IDB and WB). This fund gave full backing to the sight and saving dollar deposits in the public system and in the suspended banks. The dollar time deposits in the public banks were reprogrammed up to 3 years. On August 5, banks were re-opened and the run was progressively weakened. However a clear reversion in the flow of deposits only occurred after the restructuring of the public debt in May 2003.[23]

1.5.2 Public debt restructuring process

Argentina's Sovereign Debt Restructuring

The default declared in December 2001 affected about half of the Argentine public debt (67.8 billion dollars over a total public debt of 144.5 billion dollars). The suspension of debt service did not include the rest of the debt, constituted by debt with multilateral organizations and local debt resulting from the swap of November 2001.

The Argentine government continued issuing new debt after the declaration of the default. New debt was issued to compensate banks for their losses originated mainly by the "asymmetric pesification", to compensate savers for the pesification at a lower exchange rate than the actual, to rescue debt from provincial government, to account liabilities with purveyors, and to compensate public employees and pensioners from the cut in their nominal wages and pension benefits, that was declared unconstitutional by the Supreme Court. The new debt issued for these reasons during 2002 and 2003 amounted to 28,5 billion dollars, according to Damill, Frenkel, and Rapetti (2005).

A proposal for restructuring the defaulted public debt was made by the government in September 2003. The proposal implied a nominal cut of 75%, and was strongly rejected by the financial market. Another proposal was made in June 2004. This proposal implied the possibility of issuing a maximum of 41,8 billion dollars in bonds in exchange for a defaulted debt of 81,8 billion dollars. The proposal included 3 options for the exchange: i) *Par bonds*, implied nominal value equal to

[22] Reserves were also reduced due to Central Bank interventions at the beginning of 2002, to defend the Uruguayan peso.

[23] A more detailed description of the events of 2002 can be found in De Brun and Licandro (2005)

the original debt, 35-year maturity and fixed and increasing interest rate of 1,33% at the beginning and 5,25% at the end, ii) *cuasi-Par bonds*, implied a haircut in the nominal value of 30,1%, 42 year maturity and a fixed interest rate of 3,31%, and iii) *Discount bond*, involved a haircut of 66,3% of the nominal value, 30 year maturity and a fixed interest rate. For each bond it was stipulated a maximum issuing. The new bonds included a coupon tied to GDP growth. The proposal implied that an important part of past due interests would not be recognized.

On May 3, 2005 the acceptance of the swap reached 76,15%, and nominal debt of 62,3 billion dollars were exchanged for 35,3 billion dollars of new nominal debt. An important part of the new debt (44%) was issued in local currency; these bonds were CPI-linked. The defaulted debt that did not enter in the swap was not recognized. The operation implied a reduction of 67,3 billion dollars in public debt, and the ratio public debt over GDP was reduced from 113% to 72% due to the operation.[24]

Sturzenegger and Zettelmeyer (2008) studied several restructuring processes during the period 1998-2005, and they concluded that the Argentine swap was the "toughest" one. They computed haircuts as the difference between the present value of old and new instruments, using as discount rate the yield of the new instrument after the swap. They estimated a haircut of 73% in the Argentine case.

Uruguay's Sovereign Debt Restructuring

After the abandonment of the peg, the nominal and the real exchange rate rose, as can be seen in Figure 1.9. As a consequence, the ratio public debt over GDP also rose. The country risk, that was 217 points in December 2001, suffered an important increase after the loss of the investment grade, reaching 1038 points in May 2001. After the flotation of the peso, the country risk continued increasing and remained at more than 2000 points until May 2003, as it is shown in Figure 1.9.

This situation implied a virtual exclusion from financial markets. In March 2003 the government started a round of consultations with national and international investors about the reasons and possible characteristics of a public debt restructuring. Given that the Uruguayan government interpreted that the problem was mainly a liquidity issue,[25] the proposed swap implied basically an extension of the maturity of the bonds, maintaining the other conditions of the debt (currency, amount of the bond and interest rate). There were two available options for the swap: i) *Extension*: implied an addition of five years of the maturity of the bond, ii) *Liquidity*: implied the exchange of the bonds for "benchmark" bonds, these bonds had longer maturities, but with high amount overdue, and so better liquidity in secondary markets.

On May 15, 2003 when the period of acceptance was closed, the participation reached near 90%. The period of acceptance was extended until May 22, and finally the participation was 93%. The debt that did not enter in the swap was finally paid with the original conditions. This decision was taken in order to avoid legal problems, and with the intention to allow a quick return to the international financial markets. The decision was also favored by the fact that the implied amount of debt was relatively marginal. The result of the swap was seen as successful, and

[24] For a more detailed description of the restructuring process of Argentine public debt see Damill, Frenkel, and Rapetti (2005)

[25] According to De Brun and Licandro (2005) this interpretation was not shared by the IMF staff, that thought that the problem was a solvency one.

the market value of the debt was rapidly increased, a result that was anticipated by the bondholders and favored their participation in the swap.[26]

The already cited work of Sturzenegger and Zettelmeyer (2008), found that the Uruguayan swap was the mildest of a group of debt restructuring processes that took place during 1998-2005. They estimate a net present value haircut of 13% in the Uruguayan case. The Uruguayan GDP started to grow again after the swap.

1.5.3 Monetary and fiscal policies after crisis resolution

The free floating policy adopted by Argentina, led at the beginning to a huge depreciation of the peso. The exchange rate rose from 1 peso per dollar to 4 pesos per dollar. Exchange rate controls were introduced to avoid an excessive depreciation that could have led to a high inflation. Other anti-inflationary, non-monetary measures were adopted, as export taxes and the freezing of the public utility rates. Finally, when the capital flows were reversed, Central Bank intervened in the exchange market trying to avoid the appreciation of the peso.

Monetary policy in Argentina after the crisis was conducted using as instrument the monetary aggregates. The Central Bank was progressively used as a source of fiscal funding as fiscal deficit started to increase specially after 2011 in a context characterized by a lack of access to international financial markets. With this background inflation started to rise (inflation was 33% on average in the period july 2013-september 2016 in the city of Buenos Aires).[27] At the end of 2011 several exchange rate controls were introduced ('cepo cambiario') that were dismantled at the end of 2015. In September 2016 was announced an inflation targeting framewok that started in January 2017 with the objective to reach an inflation target of 5% in 2019. Monetary policy started to be implemented using a monetary policy interest rate that is determined each two weeks.

In the Uruguayan case after the free floating of the peso the exchange rate rose, as can be seen in Figure 1.9. The exchange rate was $ 15 per dollar at the beginning of 2002 and attained $ 32 in September, 2002. In order to avoid an increase in inflation, monetary policy was tightened by issuing treasury bills in local currency at a very high interest rate (150 %) and increasing legal reserve requirements for peso deposits. Central Bank started to follow a policy of monetary base targets in 2003. After the successful debt swap an important reversal in capital flows occurred allowing a decrease in the exchange rate ($ 27 on June 30, 2003), in the interest rate (20 % at the end of 2003), and in the inflation rate that finally was 10,2 % in 2003. In 2004 the monetary policy was based on the announcement of a monetary base target with a subsidiary inflation target. In 2006, the inflation target started to be considered the most important while the monetary target was considered subsidiary. In 2007 the monetary target was abandoned and the operational target started to be the interbank interest rate. Finally, in 2013 the monetary aggregates were taken again as instrument of monetary policy. Inflation rate has remained relatively stable but higher than the inflation target of 5%. The inflation rate was on average 8% from july 2007 to june 2017, in a context of high indexation and inflationary pressures related with the important growth process (GDP increases 4% on average in the same period).

[26] For a more detailed description of the swap, and the treatment of the holdout problem, see De Brun and Della Mea (2003)

[27] As it is commented later the aggregate official CPI data has been disputed since January 2007

The Argentine fiscal policy after the end of the convertibility succeeded in obtaining an important primary surplus. Given the important reduction in interest expenses as a result of the default and the posterior restructuring process, the consolidated public sector also registered a surplus. An important part of the improvement in the primary surplus was related to the introduction of export taxes, which coincided with a period of high commodity prices. The reserves were also augmented as a result of the interventions to avoid the appreciation of the Argentine peso. Part of these new resources were used to pay in advance the important debt with the IMF inherited from the previous period. However, progressively fiscal deficit started to increase specially after 2011 (more than 4% of GDP on average on 2011-2015).

As a result of the swap of 2005, as we commented, the ratio public debt over GDP of Argentina decreased in an important way. Given the characteristics of the swap, average debt maturity increased, and the degree of dollarization of public debt decreased. The sovereign spread sharply decreased after the swap. In the following period the average maturity of debt and the degree of dollarization remained basically the same. The ratio public debt over GDP continued decreasing, as a consequence of the high economic growth. Sovereign spread continued decreasing until the first quarter of 2007 when attained 2%, a similar level to the average emerging countries spread.

The reputational problems, that we have analyzed in Section 1.3.2, remained after the default and tough debt restructuring. Argentina faced restrictions to normally issue bonds in international markets, given the possibility of claims or embargoes by holdouts (the bondholders that did not participate in the swap). In spite of this, Argentine government managed to issue an important amount of public bonds in international markets, via an arrangement with the government of Venezuela from 2005 to 2008. This new debt was issued at a high interest rate, which was interpreted by some analysts as a symptom of fiscal problems. The process of de-dollarization of the public debt, in great part based on the issue of CPI-linked debt, also had some difficulties. The official CPI data has been disputed since January 2007. Some analysts, that consider that the inflation is underestimated, interpret this fact as a sign of reluctance to pay CPI-linked public debt, see on this Weisbrot (2008). In part due to these problems, the Argentine sovereign spread started to increase again during 2007, while the average spread of emerging markets remained basically constant. During the last quarter of 2008, and the first quarter of 2009, Argentine EMBI attained a peak. During this period there was also a general increase in emerging markets sovereign spread, due to the international crisis, but the increase in Argentina was higher than the average. The composite EMBI was 6,6%, while the Argentine EMBI was more than 16% during this period. After this peak the sovereign spread of Argentina decreased, accompaining the general trend of emerging markets, but it remained at a high value, well above the composite EMBI. In 2010 Argentina reopened the swap with partial success (more than 12 billion dollars were restructured). However, the Argentine exclusion from financial markets did not change until 2016 when Argentine government arranged with the remaining holders of defaulted debt.

The Uruguayan fiscal policy also achieved an important fiscal primary surplus after the crisis. The interest expenses represented an important fraction of the GDP after the floating of the peso, given the high degree of dollarization of the public debt but were progressively decreased accompaying the posterior appreciation of the Uruguayan peso. As a consequence total deficit evolved from a moderate deficit in 2003 to an almost equilibrium in 2007. Uruguay's fiscal deficit showed

a small deterioration in 2008, basically due to extra costs in the state-owned corporation that monopolizes electricity. During 2009 fiscal deficit suffered another minor increase, in part due to countercyclical measures adopted to confront with the international crisis, (deficit attained 1,7% of GDP). Finally, in 2010 and 2011 deficit remained in a low level (1% of GDP). In 2012 fiscal deficit increased again and remained at a relatively high level (3,2% of GDP on average on 2012-2016). On 2016 a tax package was approved with the intention to reduce fiscal deficit to 2,5% of GDP on 2019.

In October 2003, few months after the swap, Uruguay issued an important amount of public debt in the international financial markets. Country risk had a strong decrease after the swap. After that the sovereign spread continued declining, as a consequence of the high capital inflows and the improvement in the Uruguayan financial situation. In 2007 sovereign spread was 1,8%, a level lower than the average emerging countries spread. In the following period the Uruguayan spread followed the general evolution of the emerging countries spread.

The management of the public debt, looked for an improvement in its profile, increasing the average maturity (the debt with a maturity lower than 5 years represented 64% in 2002, and 44% in 2016), and increasing the proportion of the debt denominated in local currency (4% in 2002, 47% in 2016). The debt with the IMF was cancelled in advance. Public debt as percentage of GDP decreased after the crisis until 2010, from 2010 to 2016 it remained around 60% of GDP. In 2012 Standard & Poor's decided to give the investment grade status to the Uruguayan public debt, a decision followed by other credit rating agencies.

1.5.4 Some considerations about the crisis

External shocks and internal vulnerabilities

The long lasting recession and the final crisis of Argentina and Uruguay can not be explained alone by the capital flows reversal. Other Latin America economies (e.g. Brazil or Chile) suffered an even more important initial shock with lower consequences in their activity level. It seems that some local vulnerabilities, added to the sudden stop, had played an important role in the Argentine and Uruguayan crises.

Firstly, the lack of strong fiscal sustainability, made Argentina and Uruguay specially vulnerable to an increase in sovereign spread. In the Argentine case, where reputational problems were added to the sustainabilty ones, the difficulties in rolling over the debt, favored a contractionary fiscal policy that exacerbated the recession. The final explosive public debt dynamics, derived in the default and the posterior tough restructuring process.

Secondly, financial dollarization seems to have played a role in the difficulties to confront the external shock. An adverse external shock calls for a real depreciation. In a financial dollarized environment this is likely to induce financial problems. If the real depreciation is made directly by an adjustment of the exchange rate, we have the complications associated to the balance sheet effects on agents that have debts in dollars but assets in domestic currency. If the authorities does not allow the exchange rate to move and the real exchange rate adjustment is made by a process of deflation, we can also have financial problems. A deflation process usually is associated with a recession, given price rigidity, and the recession can affect the financial situation of many agents in the economy. This financial deterioration could be magnified by a final overshooting of the exchange rate, if the

process of adjustment via deflation is not successful and the abandonment of the peg is made in the middle of a crisis, as happened in Argentina and Uruguay. It seems that a process of de-dollarization can help the economy to confront with this kind of external shocks.

In third place, the exchange rate peg seems to have been a vulnerability for these economies. The exchange rate peg with respect to the US dollar was a powerful tool to reduce inflation, but seems to have been a weak instrument to deal with adverse external shocks. As it is noted by Hausmann and Velasco (2002) Argentina does not seem to satisfy the requirements of an optimum currency area with the US, and the same can be argued about Uruguay. Sudden stops are an asymmetric shock for these economies and the US, so the peg, that forced these countries to have a similar monetary policy, could not provide the correct response to the shock. Given the recurrent presence of these type of shocks it seems better to assign the task of maintaining a low inflation to a monetary policy compatible with exchange rate flexibility. An institutional framework that precludes an inflationary bias in monetary policy, can help to improve Central Bank reputation. This could reduce the necessity to import credibility from a low inflationary country via an exchange rate peg.

Banking regulation problems appeared as another vulnerability. The regulation problems seem to have not been limited to the lack of currency mismatches restrictions. The lack of a strong financial system put additional pressure on reserves, and interacted in a negative way with the fiscal front problems. The management of the financial crisis seems to have had also some deficiencies. The answer of the Uruguayan authorities to the banking run was slow. The drastic measures adopted by Argentina, first corralito and then pesification, seems also to have some drawbacks. These measures implied a quick response to the liquidity problems of the banking system and to the solvency problems of the debtors in dollars. However, these decisions were at the expense of the depositors rights, which could harm the reputation of the Argentine financial system.

Another source of vulnerability seems to have been related with the lack of macroeconomic coordination inside the Mercosur agreement. The Brazilian devaluation in face of the sudden stop implied for Argentina and Uruguay an additional adverse shock. This problem was even more important for Uruguay, that was more dependent on the region. As was already commented, the Uruguayan exports of goods to the region represented 55% of its total exports in 1998. The region had also a decisive importance, through Argentina, in the demand of the tourist and financial sector. Although its more flexible exchange rate regime allowed Uruguay to gradually adjust the relative prices after the sudden stop and Brazilian devaluation, it was extremely difficult for Uruguay to confront with the additional shock represented by the Argenine collpase at the end of 2001. This fact suggests the importance of increase the macroeconomic coordination inside the Mercosur. For Uruguay this policy probably has to be complemented with some trade diversification.

The crisis resolution

The exit from the recession was only possible when the exchange rate peg was abandoned allowing the relative prices to adjust, and when the problems associated with the combination of real exchange rate depreciation with liability dollarization (of the public debt and the financial system) were "elucidated".

The resolution of the public debt crisis in Argentina and Uruguay were quite different. In the Argentine case, the public debt was in default during 3 years, while in the Uruguayan case the public debt service was never interrupted. The Argentine swap implied a very important change in the conditions of the debt including an extraordinary haircut. On the contrary, the Uruguayan swap implied basically an increase in the maturity. The approach to the holdout problem was also very different, the debt that did not enter in the swap was paid by Uruguay while it was not recognized by Argentina and an agreement with the holdouts was reached on 2016, almost 15 years after the default.

The quite different restructuring process is the result of a different strategy, and it is not the product of a different diagnosis about the consequences of the lack of fulfillment of the debt service. Both countries supposed that this behavior would imply the exclusion from the financial markets. Based on this analysis, Uruguay tried to affect minimally the financial rights of the bondholders, searching for a small punishment and for a quick return to the financial markets. As it is argued by Damill, Frenkel, and Rapetti (2005) Argentina made a strong haircut in order to have a public debt that could be managed without issuing new public debt in the international financial market. The "self exclusion" strategy of Argentina was favored by the high interest rates of its public debt, a problem that was intensified after the "megacanje". The interest rate of the Uruguayan public debt was relatively small, given that the majority of the debt was issued under the "investment grade" status. The Argentine reputational problem could have increased after the default and could be a heavy burden for the public debt management for a long period.

This fact illustrates a sort of "vicious circle", bad reputation implies bad credit conditions, which leads to a default in some circumstances, which reinforces the bad reputation.

1.6 Conclusions

The Argentine and Uruguayan crises can be seen as the result of an adverse external financial shock in a vulnerable environment. This environment was characterized by a perverse combination of fixed exchange rate, a weak sustainable fiscal policy, and a great de facto dollarization. Banking regulation problems and the lack of macroeconomic coordination inside the Mercosur agreement, also contributed to amplify the original adverse shock.

By testing cointegration between government expenditure and revenues we find evidence that fiscal policy was only weak sustainable in Argentina and Uruguay. The lack of a "strongly" sustainable fiscal policy favored the speculative attacks against public debt suffered by these economies. This fact also restricted the possibility of following a countercyclical fiscal policy during the recession. We find no clear evidence that Uruguay and Argentina were different in terms of fiscal sustainability in the pre-crisis period. This result suggests that the different credit conditions in that period were originated in reputational considerations.

Along with the similarities the processes that finished with the Argentine and Uruguayan crises shows some differences. Uruguay had a more flexible exchange rate peg, that allowed a more gradual adjustment of the real exchange rate. The Uruguayan institutions had a better reputation, and in particular Uruguay had a better reputation as debtor. This favored the obtaining of the investment grade status for the Uruguayan public debt. Uruguay was able to issue public debt with low interest rates, and after the devaluation was in a better position to restructure

the public debt in a market friendly manner, which in turn allowed a quick return to international markets.

In the case of Argentina, the rigid exchange rate regime made the adjustment process more complicated, and the crisis resolution included a severe social and political crisis. The bad reputation, added to the lack of a strongly sustainable fiscal policy, led to the accumulation of a huge public debt with high interest rates. Argentina finally opted for a default and then imposed a very important haircut in the restructuring process. The Argentine reputational problem could have worsened after the default which implies a kind of vicious circle.

The analysis of the Argentine and Uruguayan crises shows that internal factors play a key role in the economy response to a sudden stop. This fact suggests that the most pernicious effects of these shocks could be avoided by policies that reduce the vulnerabilities that we have analyzed.

1.7 Appendix

1.7.1 Data

Unless otherwise indicated in the text the sources of the data are the following:

Argentina: GDP, GDP deflator and CPI are from INDEC. Exchange rate is from the Central Bank of Argentina (BCRA). EMBI and effective real exchange rate are from JP Morgan. Public expenditure and government revenues are from MECON, and were deflated with GDP deflator. Fiscal variables were seasonally adjusted using the Multiplicative Census X12 procedure. Public debt over GDP and public debt in dollars are from IADB. Public debt maturity and currency composition of public debt are from MECON. Deposits, credits and unrecoverable credits are from BCRA. Foreign exchange reserves in the Central Bank are from IMF. Private consumption, exports and imports are from national accounts (INDEC). Quarterly private investment was estimated from annual private investment (INDEC) using Chow-Lin method with quarterly total investment from national accounts as high frequency indicator. Current Account and terms of trade are from INDEC. Destination of exports and exports composition are from ECLAC.

Uruguay: GDP, GDP deflator and exchange rate are from Central Bank of Uruguay (BCU). CPI is from INE. UBI is from República AFAP. Public expenditure, and government revenues are from BCU, and were deflated with GDP deflator. Fiscal variables were seasonally adjusted using the Multiplicative Census X12 procedure. Public debt over GDP and public debt in dollars are from IADB. Public debt maturity and currency composition of public debt are from BCU. Effective real exchange rate is from IMF. Deposits, credits and expired credits are from BCU. Foreign exchange reserves in the Central Bank are from IMF. Quarterly private consumption, private investment, exports and imports were estimated from annual national accounts (BCU), using Chow-Lin method with quarterly IVF (BCU) as high frequency indicator. Current Account and terms of trade are from BCU. Destination of exports and exports composition are from ECLAC.

USA's CPI is from Bureau of Labor Statistics.

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

1.7.2 Condition for Fiscal sustainability

The analysis of fiscal sustainability originated by the seminal paper of Hamilton and Flavin (1986), consists on testing if revenues and expenditures including interest payments are cointegrated, provided that they are I(1) processes. This type of analysis was extended by Quintos (1995) and Martin (2000), that discuss "strong" and "weak" conditions for fiscal sustainability.

Following Quintos (1995), the government one period budget constraint is given by:

$$\Delta B_t = G_t^r - R_t \tag{1.2}$$

where B_t is the market value of the public debt, R_t is tax revenues, and $G_t^r = G_t + r_t B_{t-1}$ is government expenditures including interest payments. Assuming that r_t is stationary around the mean r, defining $E_t = G_t + (r_t - r)B_{t-1}$, by forward substitution we arrive to:

$$B_t = \sum_{j=0}^{\infty} \gamma^{j+1}(R_{t+j} - E_{t+j}) + \lim_{j\to\infty} \gamma^{j+1} B_{t+j} \tag{1.3}$$

with $\gamma = (1+r)^{-1}$. Fiscal sustainability implies that the current market value of debt has to be equal to the present value of future surplus. For this to hold, taking expectations in both sides of equation 1.3, we need that $E_t \lim_{j\to\infty} \gamma^{j+1} B_{t+j} = 0$ (i.e. bubble term has to converge to zero).

Using the difference operator in equation 1.3, and applying equation 1.2, we arrive to:

$$G_t^r - R_t = \sum_{j=0}^{\infty} \gamma^{j+1}(\Delta R_{t+j} - \Delta E_{t+j}) + \lim_{j\to\infty} \gamma^{j+1} \Delta B_{t+j} \tag{1.4}$$

In this case sustainability implies: $E_t \lim_{j\to\infty} \gamma^{j+1} \Delta B_{t+j} = 0$. Empirically we test the stationarity of $G_t^r - R_t$. Alternatively, we test for cointegration on the regression equation:

$$R_t = \mu + b G_t^r + \epsilon_t \tag{1.5}$$

The requirement of strong sustainability implies additionally that $b = 1$.

Writing Equation 1.5 into Equation 1.2 we arrive to:

$$\Delta B_t = (1-b)G_t^r - \mu - \epsilon_t \tag{1.6}$$

Using the definition of G_t^r and rearranging, we have:

$$B_t = (1 + (1-b)r_t)B_{t-1} + (1-b)G_t - \mu - \epsilon_t \tag{1.7}$$

According to Equation 1.6, ΔB_t is stationary if $b = 1$ and ϵ_t is stationary (i.e. if G_t^r and R_t are cointegrated). We will refer to this situation as "strong" fiscal sustainability.

If $0 < b < 1$, then ΔB_t is non stationary (G_t^r is non stationary), and Quintos (1995) shows that the bubble term can still converges to zero, altough at a slower rate of convergence. This will be a situation of "weak" fiscal sustainability. According to Quintos (1995), cointegration is not a necessary condition for weak sustainability. However, Martin (2000) argue that if we do not have cointegration, the interpretation of b is not clear.

TABLE 1.3: Criteria for fiscal sustainability

Cointegration	b	Sustainability
-	0	Non-sustainable
No	0<b≤1	Weak*
Yes	0<b<1	Weak
Yes	1	Strong

Note: * Following Martin (2000): Non-sustainable

In the empirical strategy non stationarity of revenues and expenditures including interest payments is tested. After that a cointegration test is applied. If it cannot be rejected the hypothesis of b=0, fiscal policy is considered non-sustainable. If there is no cointegration but $0 < b \leq 1$, fiscal policy is considered sustainable in a weak sense.[28] Fiscal policy is also considered weak-sustainable if there is cointegration and $0 < b < 1$. Finally, fiscal policy is strong sustainable if there is cointegration and b=1. These criteria are summarized in Table 1.3.

1.7.3 Testing fiscal sustainability in Argentina and Uruguay

Fiscal sustainability in Argentina and Uruguay is analyzed using monthly data from the period: 1993:1 to 2001:12. This sample is chosen due to data availability and to focus on the pre-crisis period after the implementation in 1991 of the stabilisation plans. The selected data are shown in Figure 1.10.

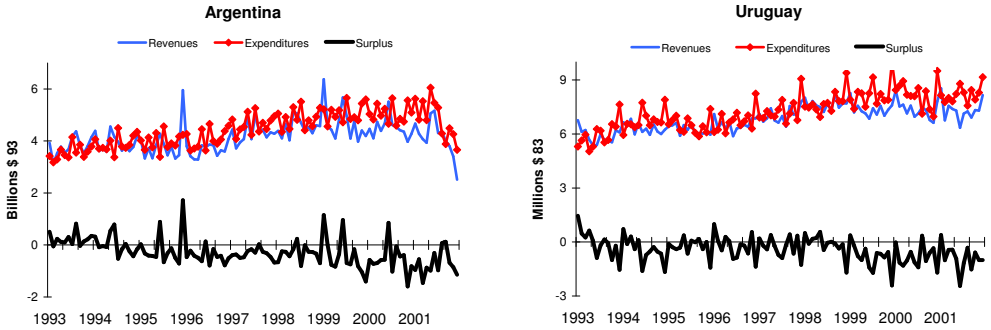


FIGURE 1.10: Argentina and Uruguay: Government Revenues and Government Expenditures, Non financial Public Sector, 1993-2001. Sources: MECON and BCU.

The data represents total government revenues and expenditures (including interest payments) from Non Financial Public Sector.

The Augmented Dickey Fuller (ADF) test is used to test the non stationarity of the data. As can be seen in Table 1.4, ADF test favored the unit root hypothesis in the four cases.

The sustainability of fiscal policy, is then analyzed by using the criteria shown in Table 1.3.

[28] As it was commented if there is no cointegration, according to Martin (2000), fiscal policy is non-sustainable.

TABLE 1.4: ADF test

Variable	Level	First difference
Revenue Argentina	-1,13	-4,71**
Expenditure Argentina	-1,07	-3,32*
Revenue Uruguay	-1,02	-3,97**
Expenditure Uruguay	-1,96	-3,65**

Note: Model with intercept and trend in level and intercept in first difference, except for Argentine revenues: model with intercept in level, and no constant, no trend in first difference. Lags according to AIC
*,** We reject the unit root hypothesis at 5% or 1%

The Johansen test is used to check cointegration. In Table 1.5 we report the trace and the maximum eigenvalue statistic for the benchmark specifications for both countries. As it is shown in Reimers (1992), in small samples the rejection rate of the null hypothesis of no cointegration is higher than the theoretical one, and so the Johansen test tends to overstimate the number of significant cointegration vectors. This problem is significatively reduced by the small sample modification of the trace statistic proposed by Reinsel and Ahn (1988). In order to consider this possible issue, this modified trace statistic is also reported in Table 1.5.

In the case of Argentina the benchmark specification includes one lag, recommended by Akaike information criteria. In order to consider seasonal effects, that seems important mainly in the revenues case, seasonal dummies are included. The specification also includes a dummy variable and its lag, that takes the value of one in 1995:12 and 1999:01; in these dates Argentina received extraordinary revenues originated in privatizations (see MECON (1995) and MECON (1999)). Finally a dummy that takes the value of one in 1997:06 and another that takes the same value in 1997:07 are included, to consider changes in the income tax legislation that implied more tax-collection on july 1997 and less in june 1997 (see MECON (1997)).[29,30] We do not include a constant in the VEC given that it was not significant. According to standard tests, the residuals seem to have a good performance in terms of whiteness and normality.

As can be seen in Table 1.5 the hypothesis of no cointegration is rejected using the three reported statistics. The null hypotesis of b=0 and the null of b=1 are also rejected. The estimated b is 0.60. Fiscal policy was sustainable only in a "weak sense" in Argentina during this period.[31]

[29] Although the inclusion of the privatizations dummy with its lag, and the other two dummies of 1997 are important to obtain normality of the residuals, the results are similar without these dummies (cointegration at 1%, and a coefficient of b equal to 0,62 instead of 0,60).

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

[31] Other specifications were checked with results consistent with the ones reported here. In particular it was used an specification with 0 lags suggested by Schwartz criteria. With this specification including the seasonal dummies and the privatization dummy, the coefficient b is 0,65 and the null of no cointegration is rejected at 1% as in the one lag specification. In this 0 lags specification, the residuals seems to have some autocorrelation problems, so the specification with one lag suggested by Akaike criteria was chosen as benchmark.

For Uruguay the benchmark specification includes 2 lags recommended by Akaike information criteria. The specification also includes seasonal dummies; the constant in the VEC is not included given that it was not significant. Based on standard tests, the residuals seem to have a good performance in terms of whiteness and normality.

TABLE 1.5: Cointegration test

	Cointegration			Coef b		
	Max Eig	Johansen Trace	Modified Trace	Estimated Coef	b Test	Fiscal Sust
Argentina	35,8**	40,5**	38,9**	0,60	0<b<1	Weak
Uruguay	11,0	15,0	14,2	0,80	b=1	Weak ⊗

Note: *,** We reject the null of no cointegration at 5% or 1%
⊗ Following Martin (2000), Non-sustainable
Lags according to AIC

As can be seen in Table 1.5, unlike the Argentine case, the hypothesis of no cointegration cannot be rejected, using the reported statistics. The estimated b is higher than the corresponding to Argentina (0,8), and the null hypotesis of b=1 cannot be rejected. According to the criteria shown in Table 1.3, fiscal policy is considered weak sustainable, also in the Uruguayan case in the pre-crisis period. Using Martin (2000) criteria, fiscal policy can be considered non-sustainable, despite the high estimated b, due to the fact that revenues and expenditures are not cointegrated in the Uruguayan case.[32]

The previous analysis suggest that fiscal policy was sustainable in a weak sense in Argentina and Uruguay. There is no clear evidence that Argentina and Uruguay were different in terms of fiscal sustainability during the pre-crisis period.

Although, according to these results, fiscal policy was sustainable in a weak sense, the lack of strong fiscal sustainability is not free of charge. The debt process is sustainable under the weaker condition, but the lack of strong fiscal sustainability implies that ΔB_t is non stationary. This makes the debt process more sensible to shocks.

With a dollarized public debt, a devaluation implies a shock that increases the weight of the public debt. Without strong fiscal sustainability this can have a high

[32]The test was also performed with other specifications, and the results in general suggests that b coefficient is higher in the Uruguayan case but the cointegration evidence is less clear. Specifically using a specification with 1 lag suggested by Schwartz criteria, including seasonal dummies, the estimated b is 0,75 (also it cannot be rejected the null hypotesis of b=1, but we are closer to the rejection; the p value of the LR test was 0,26 in the benchmark case but with this specification the p value is 0,06) . In that case using the Maximum eigenvalue statistic no cointegration is rejected at 5% level but using the Johansen trace or the modified trace statistic no cointegration is rejected only at 10% level. So using a loose criteria we can conclude that Uruguayan fiscal policy was strong-sustainable (cointegration plus b=1), but using a tough criteria it can be concluded that Uruguayan fiscal policy was not-sustainable (no clear cointegration plus Martin (2000) criteria). This suggest that the most fair classification for the Uruguayan fiscal policy is weak-sustainable also with this specification. In this one lag specification, the residuals seems to have some autocorrelation problems, so the specification with two lags suggested by Akaike criteria was used as benchmark.

and durable effect on the debt process, as happened in Argentina and Uruguay after the abandonment of the peg.

As we saw in Equation 1.7 the growth rate of debt is given by $(1-b)r$. This implies an explosive debt process under the weaker condition. The rate at which debt is exploding will be higher the smaller is b. Under the weaker condition, a sudden stop shock (that implies an increase in r), combined with a persistent recession could push debt into an unsustainable path (i.e. debt could start to grow faster than the economy).

2 External and domestic shocks during the Argentine Convertibility and its collapse

The objective of this chapter is to clarify the role played by external and internal forces during the Argentine Convertibility (1991-2001) and its collapse. Using the local projections method proposed by Jordà (2005), we find evidence of an important role of external shocks in the Russian crisis and in the end of the Convertibility. Internal vulnerabilities, expressed in particular in Argentine idiosyncratic risk shocks, were also present during the Tequila crisis and in the Convertibility collapse.

2.1 Introduction

Was the Convertibility Plan collapse in Argentina due to external shocks or was it related to domestic vulnerabilities? The main motivation of this paper is to clarify the role of external and internal forces in the economic process that happened in Argentina during the Convertibility period (1991-2001).

The Convertibility was a stabilization plan that implied a currency board, the exchange rate was fixed by law in 1 Argentinean peso equal 1 $US\$$. Four years after the launching of the Convertibility Plan, Argentina suffered a recession associated to the spillovers of the Mexican "tequila crisis". After this event, Argentina started to grow again. However after the Russian default of August 1998, Argentina suffered another important GDP drop followed by a long lasting period of economic slowdown. This process finally ended in 2001 with a big fall of output and the fixed exchange rate regime was abandoned in January 2002.

The focus of the paper is on the kind of shocks that generated the recession events that happened during Convertibility and in particular on the factors behind the collapse of the Convertibility.

The causes of the Argentine crisis of 2001 2002 have been under an important debate. However, there has been little formal empirical analysis with the aim to clearly disentangle the role of external and internal forces in the process. One study that provides a formal quantification of the contribution of external and internal shocks to the crisis is the paper of Kaminsky et al. (2009) that focus on reserves loses. Compared with that article in this paper a more careful division between external and domestic factors is provided and the focus is directly on the GDP losses. The impact of the shocks in GDP are estimated using the local projections method proposed by Jordà (2005). The local projections method is a flexible and robust semi-parametric technique to estimate impulses responses.

The analysis is focused in three external shocks and three domestic factors. To capture the possible incidence of external financial factors, the relevant international interest rate for an emerging economy is included. This factor is emphasized by the literature that considers the sudden stops of capital inflows as the main driver of the Argentine and other emerging market crisis.[1] This external variable is distinguished from the excess spread of Argentina to discuss the role of the investors perception about the Argentine fiscal policy. The GDP of Argentine commercial partners is included to analyze the, almost unexplored, incidence of this factor. The third external factor considered is the real exchange rate of commercial partners with respect to the US, an exogenous factor that for example allows to see the incidence of Brazilian devaluation of 1999. This external element was isolated from the Argentina's real exchange rate with respect to the US, a domestic variable. Finally, the third domestic factor considered (besides the already mentioned excess Argentine spread and the real exchange rate with respect to the US) is the fiscal surplus over GDP. The idea that the Argentine crisis had fiscal roots is mentioned in many papers.[2] To develop this analysis, a data base covering all the Convertibility period was constructed using several sources, the sources of the data are described in appendix 2.5.1.

To characterize in a precise way the impact of external and internal forces in the GDP performance, a simple model is developed. After that, and using the guide provided by this model, a three-step procedure is followed. First, an external VAR is used to obtain the external shocks. Second, using the external shocks as exogenous variables, domestic shocks are obtained from an internal VAR. Finally, the local projections methodology is used to generate the dynamic responses of GDP to external and domestic shocks. The local projection method has been extensively used in recent applied macroeconomic research.[3] Using the impulse response function obtained with the local projection method and the shocks, the contribution of the different sources of fluctuations to the GDP is derived. The three contractionary episodes that happened during Convertibility are analyzed in detail.

The impulse response function shows an important impact on GDP of the financial shocks (both external and internal) and also an important role in the short run of the GDP of commercial partners shocks. The impact of the real exchange rate of commercial partners shocks also seem to be relevant (in particular in the case of the Brazilian devaluation of 1999). Finally the domestic real exchange rate and the fiscal surplus shocks do not seem to have played an important role in GDP evolution (what could be the result of different effects that cancel each other out).

The relative importance of external and internal forces seems to vary according to the contractionary episode analyzed. In the "tequila crisis" episode, domestic financial shocks (expressed in the increase of the excess Argentine spread) seems to have played the main role. In the Russian crisis episode the external influences represented by external financial shocks and the Brazilian devaluation seems to

[1] See for example Calvo, Izquierdo, and Talvi (2003) or Hausmann and Velasco (2002) who 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.

[2] Examples of these literature are Mussa (2002), IMF (2003) and Powell (2002).

[3] Examples of the use of this technique to analyze emerging markets issues are Caselli and Roitman (2019) or Lodge and Manu (2019). Coibion et al. (2017) uses local projections techniques to analyze the impact in terms of inequality of monetary policy shocks. Garín, Lester, and Sims (2019) uses this technique to test in the data the new keynesian prediction that positive supply shocks are less expansionary at the zero lower bound.

have been the main responsible for the GDP drop. Finally, in the end of the convertibility, a mix of external forces expressed in the recession and depreciation of the commercial partners and internal vulnerabilities, in particular excess Argentine spread shocks, explained the GDP problems. These results have some differences with the ones of Kaminsky et al. (2009), where almost no role for external shocks in the end of Convertibility is identified.

The important role played by the excess spread shocks during the tequila crisis and in the end of the Convertibility can reflect lack of investors confidence in the Argentine public debt sustainability associated in turn with the recurrent Argentine fiscal problems.

2.2 Modelling strategy

The focus is on the determinants of Argentine GDP, during the Convertibility period. More precisely the objective is to evaluate the respective contribution of external vs internal shocks to the recession events that happened in that period and in particular to the crisis that took place in Argentina at the turn of the century. In order to do so, in section 2.2.1 a simple structural model for Argentina is developed, exploiting the information contained in a limited number of exogenous variables. This model will guide the quantitative analysis. In section 2.2.2 the options used to identify external and internal shocks by means of VAR analysis are described. In section 2.2.3 the local projections methodology used to obtain the impulse response functions (IRF) is specified. Finally, in section 2.2.4 the procedure used to obtain the historical decomposition is commented.

In the model the time unit is meant to be one month, and data used is monthly seasonal adjusted from the Convertibility period (1991:04-2002:01).[4]

2.2.1 A basic model

The demand for domestic output depends on both internal and external factors:

$$y^d = f(\text{domestic demand, external demand}) \tag{2.1}$$

Actual output is the outcome of both demand and supply shocks and is specified as follows:

$$y_t = \beta_0 + \beta_1 g_t + \beta_2 r_t + \beta_3 q_t + \beta_4 y_t^* + \mu_t^y \tag{2.2}$$

where r is the real domestic interest rate and g is an appropriate measure of fiscal policy. External influences are introduced via world output y^* and the real effective exchange rate q.[5] Other influences are captured by the output shocks μ^y.

The interest rate in open economy is determined by:

$$i_t = i_t^* + E_t e_{t+1} - e_t + \rho_t \tag{2.3}$$

where i_t^* is the international risk-free interest rate, e_t is the nominal exchange rate and ρ_t is the risk premium that Argentina has to pay.

Subtracting $E_t p_{t+1} - p_t$ from both sides and assuming $P^* = 1$ we arrive to:

$$r_t = i_t^* + \rho_t + E_t q_{t+1} - q_t \tag{2.4}$$

[4] See appendix 2.5.1 for details.

[5] Lowercase letters imply logarithms.

In a fixed exchange rate regime: $E_t e_{t+1} = e_t$, and assuming that the relative purchasing power parity holds in this case and so $E_t p_{t+1} - p_t = E_t p^*_{t+1} - p^*_t$, the following relation is achieved:

$$E_t q_{t+1} = q_t \tag{2.5}$$

Equation 2.5 implies that the real exchange rate can change each period, but the direction of the change can not be predicted at the beginning of the period. Using equation 2.5, the real interest rate can be expressed as:[6]

$$r_t = i^*_t + \rho_t \tag{2.6}$$

The risk premium ρ_t can be decomposed in the average sovereign risk that emerging countries have to pay: ρ^*_t and the additional risk associated to Argentina: ρ^{+A}_t.

$$\rho_t = \rho^*_t + \rho^{+A}_t \tag{2.7}$$

Adding to the international free risk interest rate the average premium of emerging countries, we obtain the interest rate (in dollars) that has to pay on average an emerging market (i^e_t).

$$i^e_t = i^*_t + \rho^*_t \tag{2.8}$$

As it is commonly used in the literature,[7] the relevant international interest rate for an emerging market (i^e_t) has the following dynamics:

$$i^e_t = i^e_{t-1} + \mu^{i^e}_t \tag{2.9}$$

The multilateral real exchange rate (q_t) can be decomposed as follows:

$$q_t = q^{us}_t + q^p_t \tag{2.10}$$

Where q^{us}_t is the real exchange rate with respect to US and q^p_t is the real exchange rate of commercial partners against the US.

2.2.2 Structural shocks

The three international variables considered: the emerging market interest rate (i^e), the real exchange rate of commercial partners (q^p) and the GDP of commercial partners (y^*), are exogenous factors for Argentina. As a first step, an external VAR is used to model the interactions between these variables. By this way the external shocks: the interest rate of emerging markets shock ($\mu^{i^e}_t$), the real exchange rate of commercial partners shocks ($\mu^{q^p}_t$) and the GDP of commercial partners shock ($\mu^{y^*}_t$) are recovered.

[6] In this model we are assuming $P^* = 1$, so nominal international interest rates and real international interest rates are the same. Nevertheless as it is explained in appendix 2.5.1, we subtract US inflation to the nominal international interest rates to work with real international interest rates in the empirical part. A similar procedure is followed by Kaminsky et al. (2009).

[7] See for example, Kaminsky et al. (2009) or Céspedes, Chang, and Velasco (2004).

The interactions between the domestic variables is also modeled by VAR analysis where the external shocks are exogenous variables. As a result the domestic shocks are retrieved: the idiosyncratic Argentine risk shock ($\mu_t^{\rho^A}$), the real exchange rate with respect to the US shock ($\mu_t^{q^{us}}$), the fiscal shock (μ_t^g) and the own GDP shock (μ_t^y).

External shocks

In order to identify the external shocks a recursive approach is used. The international interest rate for an emerging market, consistent with equation 2.9, is considered the most exogenous variable. The movements of this financial variable are assumed to be more related to forward looking considerations.[8]

An unexpected increase of the emerging markets international interest rate can affect contemporaneously the real exchange rate of Argentina commercial partners. The movements of the real exchange rate can be also related to movements in the current account. In this paper, this relation is not considered in order to concentrate the analysis in the most important factors to the Argentine GDP determination. The option of modelling the real exchange rate mainly as a function of financial factors, without including the current account as explanatory variable, is used in other papers, as for example in the already cited works of Kaminsky et al. (2009) and Céspedes, Chang, and Velasco (2004).

Finally, we consider that financial and real exchange rate innovations can affect in the same month the GDP performance, for example postponing consumption or investment decisions in case of an adverse shock. The assumption that GDP innovations do not affect contemporaneously the interest rate or the real exchange rate can also be justified by the fact that GDP information is available with some lags.

The relation between these variables, with the restrictions that were commented and incorporating some possible lag structure, can be expressed in matrix form as follows:

$$\mathcal{A}^* Z_t^* = \mathcal{B}^* Z_{t-1}^* + \mu_t$$

where

$$Z_t^* = \begin{pmatrix} i_t^e \\ q_t^p \\ y_t^* \end{pmatrix}, \qquad \mu_t = \begin{pmatrix} \mu_t^{i^e} \\ \mu_t^{q^p} \\ \mu_t^{y^*} \end{pmatrix},$$

and

$$\mathcal{A}^* = \begin{pmatrix} 1 & 0 & 0 \\ \xi_2 & 1 & 0 \\ \psi_2 & \psi_3 & 1 \end{pmatrix},$$

The reduced form VAR representation can be estimated:

$$Z_t^* = \mathcal{F}^* Z_{t-1}^* + \epsilon_t \,.$$

[8] According to this restriction, i^e can be affected by real exchange rate or output innovations but not in the same month.

The structural shocks are given by

$$\begin{pmatrix} \mu_t^{i^e} \\ \mu_t^{q^p} \\ \mu_t^{y^*} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ \xi_2 & 1 & 0 \\ \psi_2 & \psi_3 & 1 \end{pmatrix} \begin{pmatrix} \epsilon_t^{i^e} \\ \epsilon_t^{q^p} \\ \epsilon_t^{y^*} \end{pmatrix}.$$

that can be implemented by a Cholesky factorization of the reduced form covariance matrix of the residuals with the variables ordered as in Z_t^*.

Domestic shocks

The recursiveness assumption is also used to identify domestic shocks. The ordering among risk, real exchange rate and GDP is similar to the one considered in the external VAR for analogous considerations. Additional risk associated to Argentina is considered the most exogenous variable (more forward looking factor). Real exchange rate with respect to US is ordered second and GDP is ordered third.

Fiscal policy is considered the most endogenous factor. This option is reasonable given the measure of fiscal policy that has been chosen (fiscal surplus including interest payments).[9] Fiscal surplus can be affected by a change in the Argentine idiosyncratic risk (via an increase in interest payments for example). Changes in the real exchange rate can affect the weight in GDP of the interest payments (that are mostly in dollars).[10] An unexpected change in GDP modifies the denominator of the chosen fiscal measure and can also have consequences in terms of tax collection.

The relation between domestic variables, with the restrictions that were commented, considering external shocks as exogenous variables, and incorporating some possible lag structure, can be expressed in matrix form as follows:

$$\mathcal{A}Z_t = \mathcal{B}Z_{t-1} + \mathcal{C}X_t + \mu_t$$

where

$$Z_t = \begin{pmatrix} \rho_t^{+A} \\ q_t^{us} \\ y_t \\ g_t \end{pmatrix}, \qquad X_t = \begin{pmatrix} 1 \\ \mu_t^{i^e} \\ \mu_t^{q^p} \\ \mu_t^{y^*} \end{pmatrix}, \qquad \mu_t = \begin{pmatrix} \mu_t^{\rho^A} \\ \mu_t^{q^{us}} \\ \mu_t^{y} \\ \mu_t^{g} \end{pmatrix},$$

and

$$\mathcal{A} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ \upsilon_5 & 1 & 0 & 0 \\ \alpha_1 & \alpha_2 & 1 & 0 \\ \vartheta_5 & \vartheta_6 & \vartheta_7 & 1 \end{pmatrix},$$

$$\mathcal{C} = \begin{pmatrix} \nu_0 & \nu_2 & \nu_3 & \nu_4 \\ \upsilon_0 & \upsilon_2 & \upsilon_3 & \upsilon_4 \\ \zeta_0 & \zeta_1 & \zeta_2 & \zeta_3 \\ \vartheta_0 & \vartheta_2 & \vartheta_3 & \vartheta_4 \end{pmatrix}.$$

[9] In the literature, fiscal policy is usually considered the most exogenous domestic variable, this restriction was also used and the results remain basically the same

[10] For example an appreciation of the real exchange rate due to a domestic price increase, rises the nominal GDP in pesos while the interest payments converted to pesos remain the same.

The reduced form VAR representation can be estimated:

$$Z_t = \mathcal{F} Z_{t-1} + \mathcal{G} X_t + \epsilon_t \,.$$

The structural shocks are given by

$$\begin{pmatrix} \mu_t^{\rho^A} \\ \mu_t^{q^{us}} \\ \mu_t^{y} \\ \mu_t^{g} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ v_5 & 1 & 0 & 0 \\ \alpha_1 & \alpha_2 & 1 & 0 \\ \vartheta_5 & \vartheta_6 & \vartheta_7 & 1 \end{pmatrix} \begin{pmatrix} \epsilon_t^{\rho^A} \\ \epsilon_t^{q^{us}} \\ \epsilon_t^{y} \\ \epsilon_t^{g} \end{pmatrix} .$$

This identification scheme can be implemented by a Cholesky factorization of the reduced form covariance matrix of the residuals with the variables ordered as in Z_t.

2.2.3 Local projections

Once the structural shocks are obtained, the impact of these shocks in Argentine GDP is retrieved by means of the local projection method proposed by Jordà (2005).

Specifically the following equation is estimated:

$$\Delta y_{t+h} = \eta_h^s + \phi_h^s \mu_t^s + \sum_{j=1}^{p} \delta_{j,h} \Delta y_{t-j} + \sum_{i=1}^{l} \sum_{k=1}^{x} \gamma_{i,h}^k \mu_{t-i}^k + \omega_{t+h}^s \tag{2.11}$$

where Δy_{t+h} is the change in Argentine GDP h periods ahead, ϕ_h^s is the estimated response of Argentine GDP h periods ahead to the structural shock s, (μ_t^s), e.g., fiscal shock. The estimation includes a constant, p lags of Δy and l lags of the structural shocks (μ_t^k, that includes the structural shock under consideration and the others that we are considering, where x represents the total number of shocks). In the estimation the restriction $p = l$ is used and p is selected using different information criteria. These criteria suggest in the majority of the cases one lag, so in the estimations $p = l = 1$.

Alternatively equation 2.12 is estimated to see the accumulated effect of the shock on the level of Argentine output.

$$y_{t+h} - y_t = \eta_h^{s,a} + \phi_h^{s,a} \mu_t^s + \sum_{j=1}^{p} \delta_{j,h}^a \Delta y_{t-j} + \sum_{i=1}^{l} \sum_{k=1}^{x} \gamma_{i,h}^{k,a} \mu_{t-i}^k + \omega_{t+h}^{s,a} \tag{2.12}$$

2.2.4 Historical decomposition

Using the estimated impulse response function of Argentine GDP to each shock s: $\left\{\phi_{(h)}^s\right\}_{h=1}^{H}$ and the structural shocks μ_t^s, the historical decomposition is obtained. The historical decomposition allows to understand the contribution of the different shocks to the evolution of Argentine GDP.

In appendix 2.5.2 the procedure used to obtain the historical decomposition is described in detail.

2.3 Estimation and results

In this section the main results of the paper are presented. In section 2.3.1 the variables used are shown. In section 2.3.2 the identified shocks during Convertibility are obtained. In section 2.3.3 dynamic effects of GDP to a realization of external and domestic shocks are derived using the local projections method. In section 2.3.4 the impulse response function and the structural shocks are used to obtain the historical decomposition of Argentine GDP. Finally, in section 2.3.5 the factors behind the three recessive episodes during Convertibility are studied.

2.3.1 Preliminary analysis

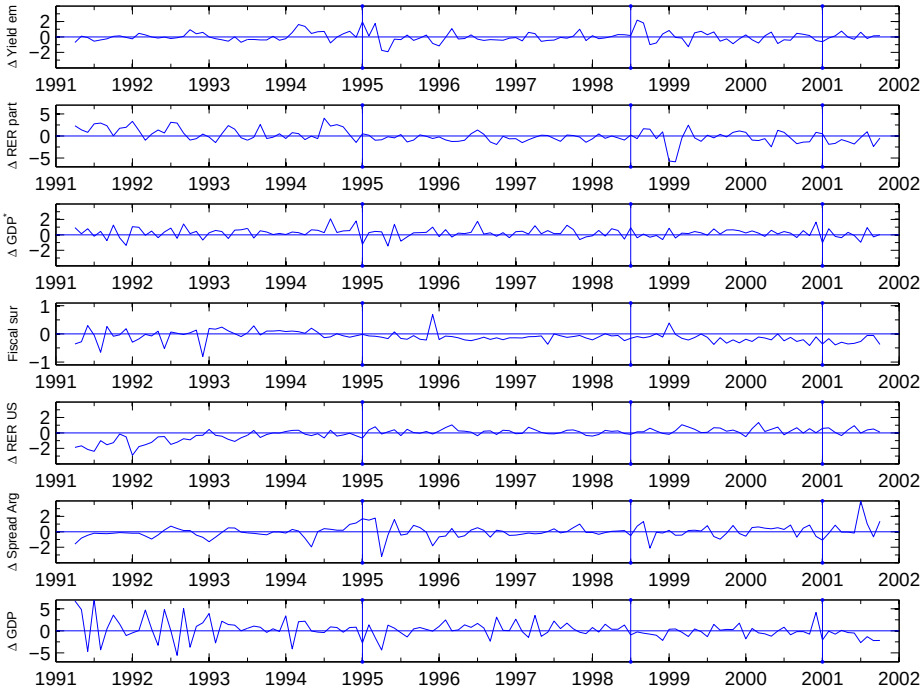


FIGURE 2.1: Benchmark variables. Argentina 1991:04-2001:10. Vertical lines indicates the beginning of recessions related to "Tequila crisis", "Russian crisis" and "end of Convertibility".

As comes out in section 2.2.1, the variables that are included in our benchmark analysis are: the emerging market interest rate in dollars (i^e) represented by the emerging market sovereign bonds yield, the real exchange rate of commercial partners (q^p), the commercial partners GDP (y^*), the additional risk associated to Argentina (ρ^{+A}), the real exchange rate with respect to US, Argentine GDP and a measure of fiscal policy represented by the fiscal surplus over GDP. The data used is monthly seasonal adjusted from the Convertibility period (1991:04-2002:01). Domestic and commercial partners GDP and both versions of the real exchange rate enter in logs. All variables seem to be I(1) except fiscal surplus over GDP, as can be seen in table 2.1, reported in appendix 2.5.3. Therefore, in Figure 2.8, and in the rest of the paper, otherwise indicated, with the exception of fiscal surplus over GDP, all variables enter in first differences. For the emerging markets interest rate in dollars the yield of emerging markets sovereign bonds deflated by US inflation is used. The sources of data are described in appendix 2.5.1.

Figure 2.8 in appendix 2.5.4, shows the behavior of these variables during Convertibility. As can be seen the real exchange rate and the excess of spread of Argentina show some extreme values at the end of the Convertibility, particularly in January 2002 for the real exchange rate and November and December 2001 for the Argentine spread. These observations can affect the parameter estimation. Given that the central objective of this paper is not to analyze the last 3 months of the Convertibility, but rather to understand the process that finally ends with the fixed exchange rate regime, these observations were excluded from the estimation as a first approximation. In figure 2.1 the behavior of the variables during the selected period is depicted.

Stationarity of the variables was tested using unit root tests. As we can see in table 2.1, reported in appendix 2.5.3, according to ADF test we can not reject the unit root hypothesis for the benchmark variables, with the exception of fiscal surplus/GDP.[11]

2.3.2 Identification of shocks: VAR analysis

The possible existence of cointegrating relations between the variables were checked using different tests. The evidence of cointegration is mixed for the case of external variables and more clear for the case of domestic variables. Different specifications for the external variables were used (VAR in levels, VEC and VAR in differences). The more appealing results, were obtained from the VAR in differences. In the VEC specification, the significant adjustment velocity coefficient, that corresponds to the RER of commercial partners, has a counter-intuitive sign.[12]

A benchmark specification with a VAR in differences for external variables and a VAR in levels with a deterministic trend for domestic variables was selected.

In the case of the external VAR a constant and one lag was included, as was suggested by several information criteria (AIC, SC and HQ).

External structural shocks were recovered following the procedure described in Section 2.2.2. The domestic VAR in levels included a constant, a linear trend, external shocks as exogenous variables and one lag for the endogenous and exogenous variables. The one lag specification was suggested by the SC and HQ criteria.

In Figure 2.2 we can see the external and domestic shocks obtained by the procedure of Section 2.2.2.

As can be seen in figure 2.2, the beginning of the recession related to the tequila crisis, coincided with some external financial shocks that were reverted some months later, and also with some Argentine spread shocks and GDP of commercial partners shocks related to the ocurrence of similar problems in regional Argentine commercial partners.

The beginning of the recession that followed the Russian default of August 1998 coincided with external financial shocks and GDP of commercial partners shocks (related with the increase in emerging market risk and the recession in Argentine partners). Some months after this event Argentina suffered and important

[11] We also run ADF tests for the first differences of the variables in order to discard the I(2) hypothesis. In all the cases the tests seem to favor the I(1) hypothesis for these variables, except for Fiscal surplus/GDP.

[12] According to this estimation, the increase in the emerging markets risk leads to an appreciation of the commercial partners of Argentina, that are mostly emerging markets. The results of single equation tests also suggest no cointegration among external variables.

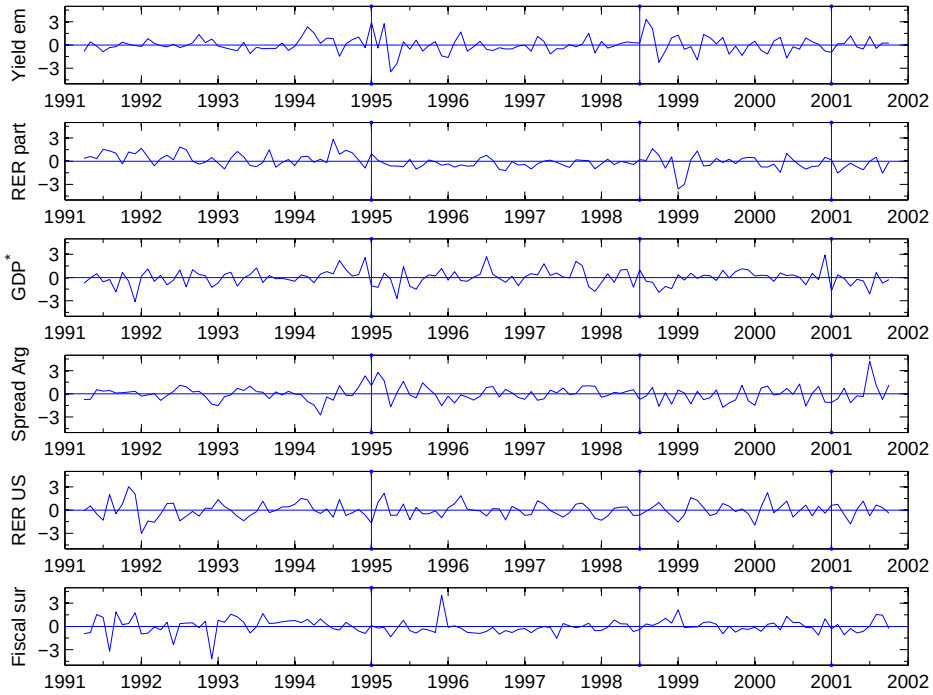


FIGURE 2.2: Estimated shocks. Argentina 1991:04-2001:10. Vertical lines indicates the beginning of recessions related to "Tequila crisis", "Russian crisis" and "end of Convertibility".

real exchange rate of commercial partners shock (associated to the Brazilian devaluation of January 1999).

In 2001 the end of the Convertibility was associated to some real exchange rate and GDP of commercial partners shocks and in the second part with Argentine spread shocks. These shocks were relatively small, except for the Argentine spread shock of July 2001.

The discussion about the contribution of these shocks to the Argentine GDP performance during Convertibility and in particular to the recession episodes will be retaken in Sections 2.3.4 and 2.3.5.

2.3.3 Impulse response functions: Local projections

In figure 2.3 we can see the impulse response function (IRF) of the Argentine GDP to external and domestic shocks. The IRF were estimated using the local projections method described in Section 2.2.3. The impulse response function shown in the figure corresponds to the accumulated effect of the shock on the level of Argentine output according to equation 2.12.

In each case we report the response of GDP to a positive realization of the shock of one standard deviation. The responses of GDP can be interpreted as percentage changes. The IRF are shown by solid lines and shaded area represents one standard error bounds. As in Jordà (2005) confidence intervals are constructed using Newey and West (1987) heteroskedasticity and autocorrelation constant (HAC) standard errors.

The upper left panel of Figure 2.3 displays the effects on GDP of an unexpected increase of one standard deviation of the yield that has to pay an emerging market bond. The initial shock implies that the interest rate that emerging markets pay increases. This shock has a persistent and significant recessive effect; GDP declines

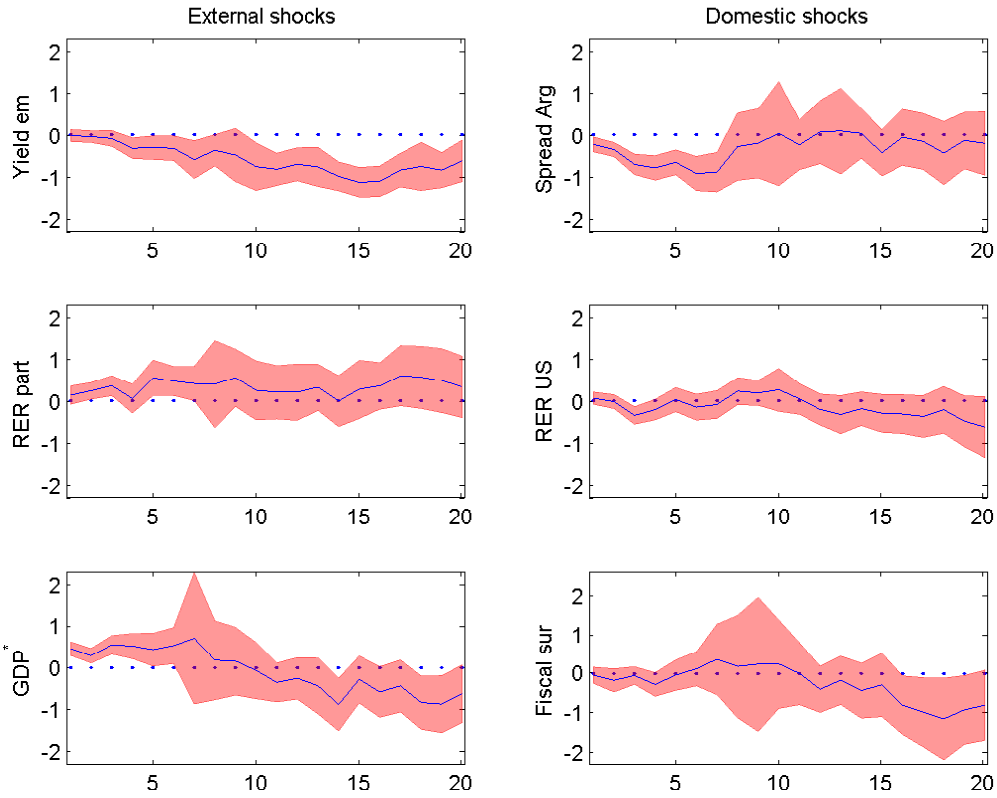


FIGURE 2.3: Effects of external and domestic shocks on Argentine GDP

after the shock. The maximum effect is attained 15 months after the shock when GDP is 1,1% lower. After that the effect on GDP starts to diminish.

An unexpected increase in the real exchange rate of Argentine commercial partners with respect to the US implies an appreciation of the currencies of these commercial partners. As a result the competitiveness of the Argentine economy is increased.

According to the IRF shown in the middle left panel of Figure 2.3, an unexpected increase in the real exchange rate of Argentine commercial partners has an expansive effect on GDP, GDP increases 0,1% in the first period after the shock, and the effect is close to half a percentage point, 1 quarter after the shock. The subsequent effect fluctuates around this number. The effect on GDP is non significant from 8 months onwards

A GDP of commercial partners shock has a significant expansive effect on Argentine GDP, during the first 6 months after the shock, according to the lower left panel of Figure 2.3. The increase of GDP is around 0,5%, and after 9 months the positive effect is reverted.

The increase in the idiosyncratic Argentine risk has a contractionary effect on GDP. In the upper right panel of Figure 2.3 it can be seen that this shock promotes a decrease of Argentine GDP, that has a maximum at the sixth or seventh month after the realization of the shock (the GDP drop is around 1%).

An unexpected real exchange rate depreciation with respect to US can increase output via an improvement in competitiveness that fosters net exports.[13] In a dollarized economy it can also have negative effects on the balance sheets of agents with debts in dollars.

According to the middle right panel of Figure 2.3 the balance sheet channel seems to prevail (which could be related to the fact that Argentina was a relatively closed economy with a widespread dollarization). The recessive effect however seems to be relatively minor. The only significant effect happens two months after

[13] It 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.

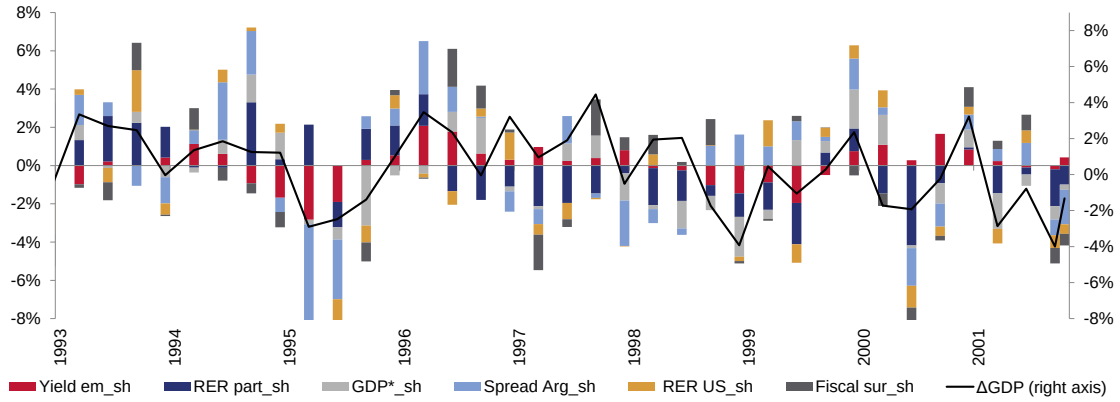


FIGURE 2.4: Historical decomposition Argentine GDP 1993-2001. Quarterly growth rate

the shock where GDP decreases 0,35% as a consequence of the unexpected real exchange rate depreciation.

An increase in fiscal surplus can have some beneficial effect on sovereign risk and on the economy, but at the same time the measures needed to achieve it can have recessive effects. In the estimation presented in the lower panel of Figure 2.3 the recessive effects seem more important. The reported effects are non significant with the exception of some contractionary effects one year and a half after the shock.

2.3.4 Historical decomposition

Using the impulse response function and the structural shocks, the historical decomposition is obtained.

As can be seen in figure 2.4, according to this historical decomposition, the growth process previous to the tequila crisis of late 1994, was fueled by real exchange rate of commercial partners shocks (that implied an increase of the competitiveness of Argentine economy). Argentine growth was also benefited during this period by GDP of commercial partners shocks and by Argentine spread shocks. The excess spread paid by the Argentine bonds decreased systematically in the first half of the nineties, from 100 basis points to negative values before the tequila crisis (Argentine risk was lower than the average emerging markets risk at that moment). The identified excess spread shocks until mid 1994, were negative, which had expansive effects over Argentine GDP.

The drop of Argentine GDP during 1995 was related to the negative external financial shocks implied in the Mexican "tequila crisis". These negative shocks were reinforced by Argentine excess spread shocks.

These financial shocks were reverted during 1996, which had beneficial effects for Argentine GDP. Argentine GDP was also benefited by GDP of commercial partners shocks and the appreciation of Brazilian currency at the beginning of the Real plan and the associated real exchange rate of commercial partners shock.

In mid 1998 Argentine GDP started to decline. This drop was promoted by external financial shocks associated to the increase in emerging markets risk after the Russian default of August 1998. There were also GDP of commercial partners shocks at the time. At the beginning of 1999, the Brazilian devaluation implied a negative real exchange rate shock for the Argentine economy.

The idiosyncratic Argentine risk was a relevant source of problems for Argentine GDP at the end of Convertibility. In the second part of 2001, Argentine risk

started to rise strongly, (Argentina experimented excess spread shocks). In addition to these internal financial shocks, during 2001 there were also some negative GDP of commercial partners shocks, and real exchange rate of commercial partners shocks that harmed the Argentine economy.

The GDP shock also played a role in some periods, associated to events not reflected in the shocks showed in figure 2.4. One example is the second quarter of 2001, where the GDP drop can not be explained by the shocks reported in figure 2.4. This issue will be analyzed in next section.

2.3.5 Episode analysis

In this section an analysis of three episodes is presented (Tequila crisis, Russian crisis and the end of Convertibility). In these three cases Argentine GDP experimented an important drop. In the first two episodes the GDP declined around 7% in each case. At the end of the Convertibility Plan the drop in Argentine GDP was around 17% (from December 2000 to January 2002)[14].

This exercise focuses in shocks that took place during the window that is being considered.

Tequila crisis

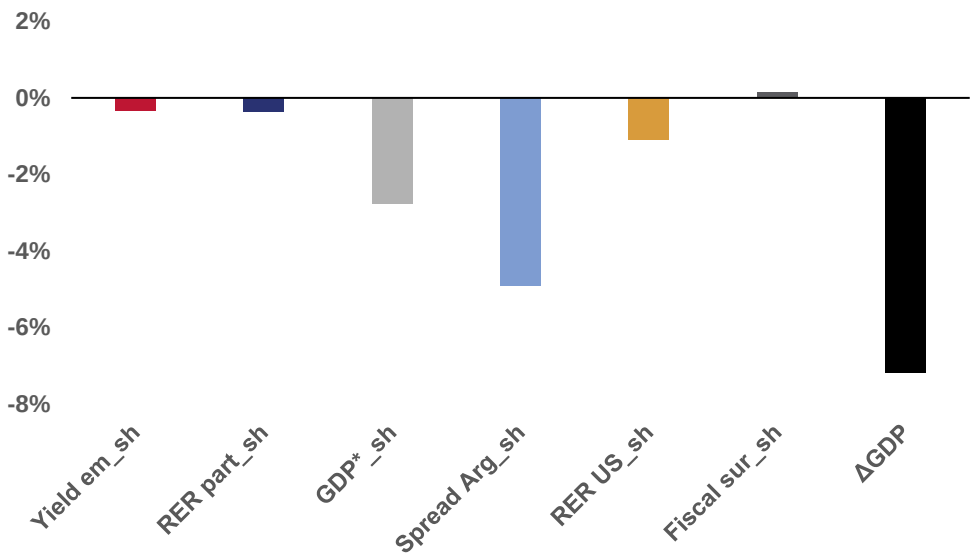


FIGURE 2.5: Argentine GDP: 1995:01-1995:08.

In figure 2.5 the drop of Argentine GDP from January 1995 to August 1995 is explained by shocks that happened during this period. As can be seen the shock that had more explanatory power was the excess spread shock. This shock was responsible of almost 5% of GDP decrease. The increase in the average emerging market risk was important at the beginning of this period but from April 1995 it started to decrease, and Argentina benefited from some positive external financial shocks. As a consequence, considering the whole period, this source was not so important as explanation of the recession. The GDP of commercial partners shock

[14] In Section 2.3.5 the analysis is concentrated in the period December 2000 to October 2001, where the fall in GDP was around 12%

also helps to explain the recession that happened in Argentina in that period (related to a decline in Brazilian and Uruguayan GDP).

These results can be compared with the Kaminsky et al. (2009) ones. The methodology of Kaminsky et al. (2009) has some relevant differences with the one developed here. The paper of Kaminsky et al. (2009) uses a VAR model concentrated in the losses of reserves, the variables used are not the same as here, and the analyzed episodes are not defined strictly in the same way.

In spite of these differences, it can be compared the source of fluctuations (broadly defined) in each episode. For example, in the case of the Argentine problems in the Tequila crisis, Kaminsky et al. (2009) finds that the external financial conditions were the main source of explanation. According to the results reported here, the financial conditions were the main explanation but specially the worsening of the internal financial conditions (expressed in the Argentine excess spread shocks).

Russian crisis and Brazilian devaluation

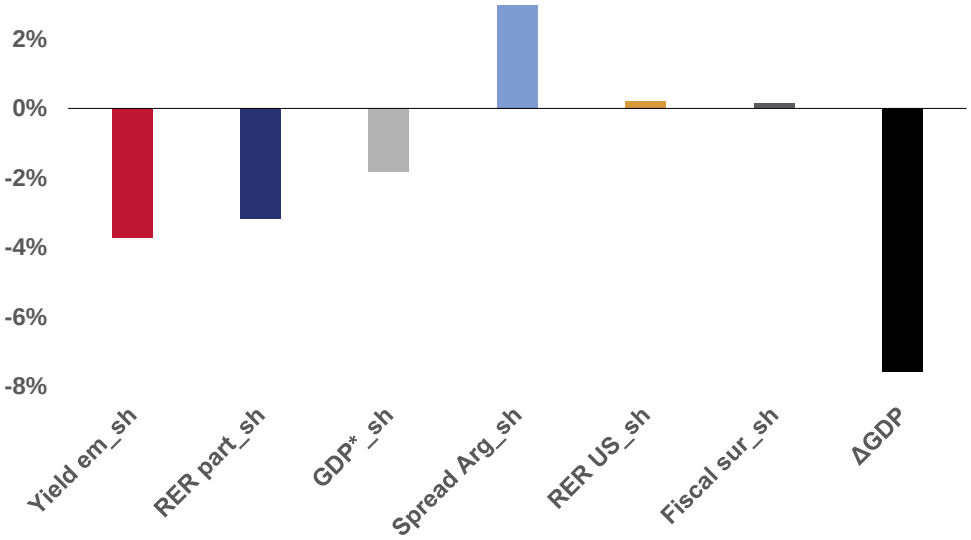


FIGURE 2.6: Argentine GDP: 1998:07-1999:07.

The Argentine GDP decrease that followed the Russian default of August 1998 can be explained according to figure 2.6 by external shocks. The most important shock to explain the GDP behavior was the external financial shock implied by the huge increase of emerging markets risk. The second important shock was the real exchange rate of commercial partners shock associated to the Brazilian devaluation. Finally, problems in the activity level in Brazil, Chile and other emerging economies also helped to explain the decline in Argentine output.

These shocks were offset in part by Argentine idiosyncratic risk shocks. Argentine risk had an important increase after the Russian default of 17th August 1998, as happened with the emerging markets average risk. However at the end of September 1998 Argentine risk started to decline in a clearer way than what happened to the average emerging market risk. As a consequence Argentina experienced some negative excess spread shocks (with a positive effect on output). In the domestic front, there were also some negative GDP shocks (not reported in figure 2.6)

End of Convertibility

The significant fall in Argentine GDP that started at the beginning of 2001 was related, according to figure 2.7, with a combination of external and domestic shocks.

In the external side, the GDP of commercial partners shock explained almost 3% of the GDP drop. At that moment the main commercial partners suffered a GDP slowdown or directly entered in recession. US economy suffered a mild recession between March and November 2001,[15] this recession seems to be related with the burst of the dot-com bubble and with the September 11 attacks. In Europe, France and Germany entered in a recession in the second part of 2001. At the regional level, Brazil also suffered a slowdown during 2001 and Uruguay was in recession. The real exchange rate of commercial partners shock explained a similar figure of the Argentine GDP drop, notably related to the important depreciation of Brazilian currency during 2001.

In the domestic front, the Argentine spread shock explained 2% of the GDP decrease. The idiosyncratic risk was not a relevant explanation of the beginning of the long lasting recession that Argentina experimented after the Russian crisis. However, in mid 2000 Argentine spread started to increase more than the average of emerging markets. At the beginning of 2001 the increase of the Argentine spread was halted and Argentine idiosyncratic risk experimented a decline. The risk reduction seems to be related to the announcement at the end of 2000 of an IMF aid package called "blindaje" (shielding). This reduction implied small spread shocks with positive effects on Argentina GDP. In March 2001 Argentine spread started to increase again and on July 2001 the important rise of Argentine risk implied the biggest spread shock during the analysed period. The shock of July 2001 had an impact of around $-3,5\%$ on GDP. During this period there were also some small negative shocks (August and October) that represented another half percent of GDP drop. These negative spread shocks were partially compensated by the shocks of the beginning of 2001 (that implied a positive effect on GDP of around 2%). Altogether these shocks implied the 2% drop on GDP due to Argentine spread shocks reported in figure 2.7.

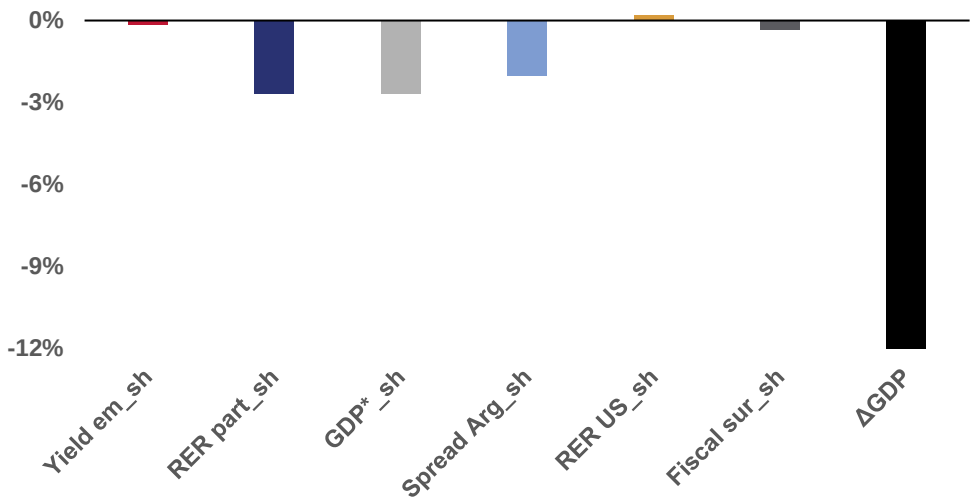


FIGURE 2.7: Argentine GDP: 2001:01-2001:10.

[15] See the July 2003 Business Cycle Dating Committee of the NBER.

According to figure 2.7, the fiscal shock does not appear to be a relevant explanation of the recession. Public expenditure on wages, public consumption and investment experienced an important reduction during this period with a direct impact on aggregate demand. This policy was particularly clear in mid 2001 with the implementation of the "zero deficit" policy.[16] Our model identifies some positive fiscal surplus shocks in mid 2001 (implying an unexpected increase in fiscal surplus), that had a negative impact on GDP of about $0,8\%$. However the model identifies some unexpected decrease in fiscal surplus at the beginning of 2001 that implied a positive impact on GDP of $0,5\%$, so at the end the net impact is not very relevant. The fiscal stance could have played a role through Argentine spread. The strong increase in the Argentine risk could be associated with the persistent fiscal deficit that occurred during the Argentine economic slowdown that followed the Russian crisis.

The GDP shock also played an important role in the end of convertibility, associated to events not reflected in the shocks showed in figure 2.7. For example, in the banking sector the withdrawal of deposits that started by the end of 2000, was intensified during 2001.[17] The drop in deposits was accompanied by a reduction in banking credits. The "credit crunch" favored an important fall in private consumption and investment.

As was commented in the case of the "Tequila crisis" episode, these results can be compared with Kaminsky et al. (2009), despite the methodological differences. According to Kaminsky et al. (2009), external financial conditions played a limited role in the end of the Convertibility, which is consistent with the analysis reported here. However, Kaminsky et al. (2009) suggests almost no role for external conditions in the end of Convertibility, while the analysis of this section finds an important role of real exchange rate and GDP of commercial partners shocks. The other element that had important explanatory power according to the analysis of this section is the idiosyncratic Argentine risk (a factor not considered by Kaminsky et al. (2009)); if the last three months of Convertibility are included (November 2001 to January 2002), the importance of this factor could be even greater.

2.4 Conclusions

This paper provides a quantitative assessment of the relative importance of external and internal shocks during the Convertibility period and the crisis that finally ends with its collapse. In the paper emphasis is put on separate external and internal forces during Convertibility. Some variables are divided in an external component and a domestic one, and a different procedure is followed to identify external and domestic shocks. The impact of these shocks in the GDP is evaluated by means of the local projection method proposed by Jordà (2005). The analysis is concentrated in three events where Argentina experienced a significant drop in output during Convertibility.

The relative importance of external and internal forces seems to vary according to the contractionary episode analyzed. In the "tequila crisis" episode, domestic financial shocks (expressed in the increase of the excess Argentine spread) seems to have played the main role. In the Russian crisis episode the external influences

[16] This policy implied a 13% cut in public wages and pension benefits, and reductions in public investment.

[17] In December 2001, the problems in the financial sector motivated the imposition by the government of several restrictions on cash retirements (the "corralito").

represented by external financial shocks and the Brazilian devaluation seems to have been the main responsible for the GDP drop. Finally, in the end of the Convertibility, a mix of external forces expressed in the recession and depreciation of the commercial partners and internal vulnerabilities represented by excess Argentine spread shocks and the GDP shock explained the GDP problems. These results have some differences with those of Kaminsky et al. (2009), where almost no role for external shocks in the end of Convertibility is identified.

The important role played by the excess spread shocks during the tequila crisis and in the end of the Convertibility can reflect lack of investors confidence in the Argentine public debt sustainability associated in turn with the recurrent Argentine fiscal problems.

2.5 Appendix

2.5.1 Data

External series

GDP of commercial partners

GDP of commercial partners (y^*) was constructed as a weighted average of the main Argentina commercial partners GDP. The weights were defined according to the participation on Argentine exports (X) during the Convertibility period. The selected partners were: Brazil (25% of X, 38,7% of y^*), EU 19 (19% of X, 29,4% of y^*), USA (9,8% of X, 15,2% of y^*), Chile (7,6% of X, 11,7% of y^*) and Uruguay (3,2% of X, 5% of y^*). The exports to these countries/economic zones represented 64,4% of total Argentine exports during Convertibility.

Destination of Argentine exports are from ECLAC.

As a general procedure, the monthly seasonal adjusted GDP was estimated from quarterly seasonal adjusted GDP using Chow-Lin method with monthly seasonal adjusted industrial production index as high frequency indicator. In the case of Uruguay other monthly statistics were also used as high frequency indicators.

The correlation between GDP and the monthly indicators used, were during the analysed period: 95,8%, 96,1%, 99,0%, 95,8% and 85,9% for Brazil, EU 19, USA, Chile and Uruguay respectively.

GDP of Brazil

Data from GDP and industrial production index were taken from the IBGE.

GDP of EU 19

Data from European Union (EU 19) GDP is from OECD. The Euro Area includes the following 19 countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia and Spain. Data from EU 19 is available from 1995. From 1991 to 1995 a series of EU 19 core was constructed using the GDP of the 12 more important economies that represents 97% of EU 19. The two series were merged using quarterly variation.

Data from industrial production index was taken from Eurostat.

GDP of USA

Data from GDP and industrial production index were taken from the Federal Reserve Economic Data (FRED), Economic Research Division of the Federal Reserve Bank of St. Louis.

GDP of Chile

Data from GDP was taken from Central Bank of Chile. Data from industrial production index was taken from INE.

GDP of Uruguay

Data from GDP was taken from the Central Bank of Uruguay. Data from monthly indicators were taken from INE and Central Bank of Uruguay.

Emerging markets interest rate

Real emerging markets interest rate was obtained using the yield of emerging markets sovereign bonds from JP Morgan deflated by US expected GDP deflator inflation. Expected GDP inflation in period t is computed as the average of inflation in the current period and in the eleven preceding months. This procedure is similar to the one developed in Neumeyer and Perri (2005).

Monthly GDP deflator was estimated from quarterly GDP deflator using Chow-Lin method with monthly CPI as high frequency indicator. US GDP deflator and US CPI are from FRED.

Real exchange rate of commercial partners with respect to US

The real exchange rate of commercial partners with respect to US is obtained by dividing the effective real exchange rate by the real exchange rate of Argentina with respect to US. Effective real exchange rate are from JP Morgan. The construction of the real exchange rate of Argentina with respect to US is explained below.

Domestic series

GDP

In a similar vein as in the case of the GDP of commercial partners, monthly seasonal adjusted GDP was estimated from quarterly seasonal adjusted GDP using Chow-Lin method with seasonal adjusted IMAE as high frequency indicator in the period that it is available (1993-2002) and with seasonal adjusted industrial production index (IPI) in the first two years.

The correlation between GDP and the monthly indicators used, were during the relevant period: 100% and 86, 5% for IMAE and IPI respectively.

GDP and IMAE are from INDEC. IPI is from Fundación de Investigaciones Económicas Latinoamericanas (FIEL).

Argentine excess spread

The Argentine excess spread was constructed by subtracting yield of emerging markets sovereign bonds from Argentine interest rate of government dollar denominated bonds.

Monthly interest rate of government dollar denominated bonds was estimated from quarterly interest rate of government dollar denominated bonds using Chow-Lin method with Argentine EMBI as high frequency indicator in the period that it is available (1994-2002) and with general EMBI in the first three years.

The Argentine interest rate of government dollar denominated bonds was taken from Neumeyer and Perri (2005).

Fiscal surplus over GDP

Public expenditure and government revenues are from MECON and were deflated with GDP deflator. Fiscal variables were seasonally adjusted using the Multiplicative Census X12 procedure. The obtained fiscal surplus was divided by GDP.

Real exchange rate with respect to US

The real exchange rate with respect to US was constructed using Argentine CPI from INDEC, exchange rate with respect to US from the Central Bank of Argentina (BCRA) and US CPI from Bureau of Labor Statistics.

2.5.2 Historical decomposition

This section explains how the contribution of each shock μ^s to the evolution of Argentine GDP is derived.

Using the procedure described in Sections 2.2.2 and 2.2.2 a $(T * 1)$ vector M^s for each shock μ^s is obtained, containing the total number (T) of estimated realizations of shock μ^s.

After that, by means of equation 2.11, a $(1 * H)$ vector Φ^s that contains the impulse response function of Argentine GDP to each shock μ^s is constructed. The first element of Φ^s, represents the contemporaneous response of GDP to a realization of the shock in t, the second element of Φ^s, represents the response of GDP in $t+1$ to a realization of the shock in t, and so on until the last element that represents the response of GDP in $t+H-1$ to a realization of the shock in t.

Using column vector M^s and row vector Φ^s, a $(T * H)$ matrix C^s can be constructed as follows:

$$M^s \Phi^s = C^s \tag{2.13}$$

In this matrix, $C^s(t,1)$ contains the contemporaneous contribution to the GDP of a realization of this shock in t; $C^s(t,2)$ contains the contribution to the GDP in $t+1$ of a realization of this shock in t, and so on until $C^s(t,H)$ that contains the contribution to the GDP in $t+H-1$ of a realization of this shock in t.

The contribution of the shock μ^s to the t observation of GDP (CY_t^s), can be obtained by summing the contemporaneous contribution to the GDP of a realization of this shock in t $(C^s(t,1))$, the contribution to the GDP in t of a realization of this shock in $t-1$ $(C^s(t-1,2))$ and so on until the contribution of the realization to the GDP in t of a realization of this shock in $t-H+1$ $(C^s(t-H+1,H))$:

$$CY_t^s = \sum_{i=1}^{H} C^s(t-i+1,i) \tag{2.14}$$

By generalizing equation 2.14 to the different observations of GDP and to the different shocks the historical decomposition showed in this paper can be obtained.

2.5.3 ADF test

TABLE 2.1: ADF test

Variable	Statistic	5% critical value
Yield em	-2.77	-2.88
RER part	-0.47	-2.88
GDP*	-1.63	-3.45
Spread Arg	-2.77	-2.88
RER US	-0.42	-2.89
GDP	-0.48	-3.45
Fiscal sur	-6.59	-2.88

Note: RER part, RER US, GDP and GDP* in logs. Model with intercept and trend for GDP and GDP*, and with intercept for the others. Lags according to SIC.

2.5.4 Benchmark variables. Convertibility period

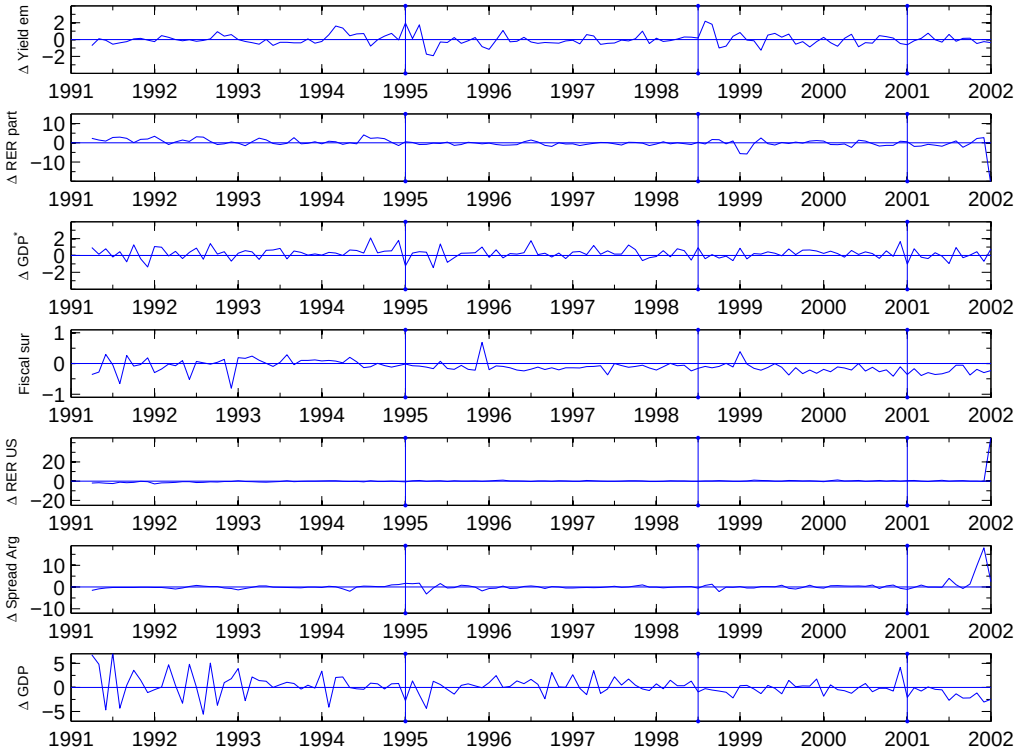


FIGURE 2.8: Benchmark variables. Convertibility period 1991:04-2002:01

3 Balance sheets and fiscal and exchange rate policies

This chapter[1] analyzes the optimal combination of fiscal policy and exchange rate flexibility in a dollarized small open economy that has to cope with external shocks. Our analysis suggests that a countercyclical fiscal policy dominates other alternatives. The choice of the exchange rate regime is a second-order decision when fiscal policy is countercyclical enough. A flexible exchange rate policy seems to be required if fiscal policy is not sufficiently countercyclical.

3.1 Introduction

What are the fiscal and exchange rate optimal policies to cope with adverse external shocks has been one of the most controversial topics in the macroeconomic literature of the last decades.

According to Erbil (2011), optimal fiscal policy both from a Keynesian or neoclassical perspective should smooth output volatility. Lane (2003) argues that the countercyclical fiscal policy recommendation is clearer in the Keynesian case. However there exists evidence that fiscal policy has been typically procyclical in emerging economies as it is documented among others in Kaminsky, Reinhart, and Végh (2004) and Végh and Vuletin (2012).[2] This evidence has motivated a theoretical literature that tries to explain this fact. For example, Végh and Vuletin (2012) argue that procyclical fiscal policy can emerge as an endogenous response in a static economy with incomplete markets. Cuadra, Sanchez, and Sapriza (2010) find that procyclical fiscal policy can be optimal in an incomplete markets economy with endogenous borrowing constraints.

At the same time there has been a lot of debate about the more convenient exchange rate regime in a dollarized context. The traditional policy prescription was that flexible exchange rates facilitates macroeconomic adjustment and mitigates the output effects after a foreign shock (see for example the Mundell Flemming model). However many papers have emphasized that devaluation can have harmful consequences (via balance sheet effects) in a dollarized economy with important financial frictions, see for example Calvo and Reinhart (2002) or Krugman (1999).

The objective of this paper is to analyze the optimal combination of cyclical behavior of fiscal policy and exchange rate flexibility in a dollarized small open economy that has to cope with external shocks. We investigate how fiscal and exchange rate policies can mitigate the problems associated with nominal rigidities, financial frictions and liability dollarization, typically found in emerging economies.

[1] This chapter is co-authored with Henri Sneessens.

[2] In advanced economies evidence suggests that fiscal policy has been countercyclical or acyclical.

Although many papers study the optimal exchange rate regime or the optimal cyclicality of fiscal policy, there are no studies (to the best of our knowledge) that analyze both at the same time, that is the goal of this paper.

We extend the model of Céspedes, Chang, and Velasco (2004) by including a public sector that collects taxes, and issues public bonds in international markets in foreign currency. The existence of mixed exchange rate is allowed, reflecting the fact that many countries follow this kind of regime.[3]

We study the effects of a financial shock in a flexible exchange rate regime and in a fixed one, and we also discuss the combination of these exchange rate regimes with a fiscal policy that can be neutral, countercyclical or procyclical. We try to see the results in terms of several key macroeconomic variables (output, consumption, investment, exchange rate and others) both analytically and by simulating the model numerically. The numerical analysis enable us to see how the equilibrium is changed when we gradually modify the degree of exchange rate flexibility or the degree of fiscal policy cyclicality.

As in Céspedes, Chang, and Velasco (2004) we distinguish a situation of financial vulnerability from a situation of financial robustness. There are negative balance sheet effects associated to a devaluation (corporate dollarized debt) and positive effects of a devaluation (asset side). Our model provides another possible rationality to fixed exchange rates. Given that public debt is dollarized, a less volatile exchange rate implies a lower volatility of public debt service, a lower volatility of taxes, and a lower volatility of consumption. Under a neutral fiscal policy, flexible exchange rates dominate fixed exchange rates as in Céspedes, Chang, and Velasco (2004). The intuition is that an external shock requires a real devaluation, that can be reached by two ways: nominal depreciation (flexible exchange rates) or deflation (fixed exchange rates). In both cases we have negative balance sheet effects, but with fixed exchange rates (and nominal rigidity) we have an additional recessive effect.

We find that fiscal policy can reduce the intensity of the financial friction, and a countercyclical fiscal policy diminishes the probability of being in a vulnerable situation. The system seems to be more stable under a countercyclical fiscal policy. Under a strong procyclical fiscal policy the equilibrium is not determined.

Another result is related to the recessive effect of fixed exchange rates. For a very tough countercyclical fiscal policy, we are close to replicate (via fiscal policy) the output result of flexible exchange rates. This result has similarities with the one of Farhi, Gita, and Itskhoki (2014), although their analysis is made in a different setting where financial frictions and dollarization are not considered.[4]

A second-order approximation to the utility of the representative consumer, is used to compute expected welfare losses associated to different combinations of

[3]The International Monetary Fund classifies the exchange rate arrangements in 10 different categories (see International Monetary Fund (2016)). These categories are grouped in three main groups: hard pegs (2 categories), soft pegs (5 categories) and floating regimes (2 categories); in addition there is one residual category. According to Ilzetzki, Reinhart, and Rogoff (2017) the world is divided in two halves: approximately half of the world GDP have more flexible arrangements and the other half crawling or hard pegs. These authors disagree with the IMF's view, that classifies 70 percent of world GDP in the more flexible categories. One of the main differences between the two classifications is the treatment of the Eurozone (EZ). The IMF consider the EZ similar to a single sovereign country with a flexible exchange rate, while Ilzetzki, Reinhart, and Rogoff (2017) consider the EZ as a rigid exchange rate arrangement.

[4]This literature about "fiscal devaluation" was inspired by the situation of some countries inside the Euro area, specially Greece.

policies in the case of a financial shock, and to select the one that minimizes these losses.

Our analysis suggest that a countercyclical fiscal policy dominates other alternatives (procyclical or neutral fiscal policy). A countercyclical fiscal policy can help households to do what they would do if they have the means to do it (smooth consumption).

The choice of the exchange rate regime is a second order-decision when fiscal policy is countercyclical enough, although in this case fixed exchange rates are optimal. A more flexible exchange rate policy seems to be required if fiscal policy is less countercyclical.

3.2 The model

We model a small open dollarized economy with nominal frictions. The economy is inhabited by workers that supply labor to firms, consume and pay taxes, and by entrepreneurs that consume and invest. To finance investment, entrepreneurs use their net worth and borrow abroad in foreign currency. The borrowing process is subject to frictions. The public sector collects taxes and issues public bonds in dollars in international markets.

The modelling strategy is similar to that of Céspedes, Chang, and Velasco (2004) with the inclusion of a public sector.

3.2.1 Private sector

Competitive firms produce home output by a Cobb Douglas production function:

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha},\ 0 < \alpha < 1,\ A > 0 \tag{3.1}$$

where Y_t is home output, K_t is capital, and L_t is labor.

L_t is an aggregate of heterogeneous workers: $L_t = \left[\int_0^1 Y_{it}^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}$

The demand for worker i's labor is given by:

$$L_{i,t} = \left(\frac{W_{i,t}}{W_t}\right)^{-\sigma} L_t \tag{3.2}$$

Using the first order conditions with respect to capital and labor we obtain equations 3.3 and 3.4.

$$R_t K_t = \alpha P_t Y_t \tag{3.3}$$

where R_t is the rental rate of capital in pesos, and P_t is the price of the home good in pesos.

$$W_t L_t = (1-\alpha) P_t Y_t \tag{3.4}$$

The utility function of workers is given by:

$$\frac{C^{1-\varsigma}}{1-\varsigma} - \frac{\sigma-1}{\sigma v} L_{it}^{v} \tag{3.5}$$

In most part of this paper we assume $\varsigma = 1$, and so the utility function is:

$$\log C_{it} - \frac{\sigma - 1}{\sigma v} L_{it}^{v} \tag{3.6}$$

Consumption (C_{it}) is a composite of domestic production (C^H) and imported (C^F):

$$C_{it} = \frac{(C_{it}^H)^{\gamma}(C_{it}^F)^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}, 0 < \gamma < 1$$

The budget constraint of workers (they only consume and pay lump sum taxes) is the following:

$$W_{it} L_{it} = P_t C_{it}^H + S_t C_{it}^F + P_t T_t \tag{3.7}$$

Maximizing consumption subject to budget constraint we arrive to:

$$Q_t C_t = W_t L_t - T_t P_t \tag{3.8}$$

where price level is:

$$Q_t = P_t^{\gamma} S_t^{1-\gamma} \tag{3.9}$$

where γ is the domestic products expenditure (constant) share of income, and S_t is the nominal exchange rate (peso price of one dollar).

W_{it} is set before observing the realization of the shocks in t, workers commit to supply labor so as to satisfy equation 3.2, given that we have:

$$_{t-1}L_t^{v} = 1$$

In period t the risk neutral entrepreneurs invest (K_{t+1}) in domestic goods and imported production that are combined in the same way as consumption, and so the price of one capital good is Q_t. To finance their investment they use their net worth $P_t N_t$ and they borrow abroad in dollars $S_t D_{t+1}$.

$$P_t N_t + S_t D_{t+1} = Q_t K_{t+1} \tag{3.10}$$

Given that borrowing is subject to frictions, the expected rate of return to capital (left hand side of equation 3.11) has to be higher than the risk free interest rate for dollars borrowed between t and $t+1$ (ρ_{t+1}).

$$\frac{_t(R_{t+1} K_{t+1} / S_{t+1})}{Q_t K_{t+1} / S_t} = (1 + \rho_{t+1})(1 + \eta_{t+1}) \tag{3.11}$$

where the safe interest rate ρ_{t+1} is a random variable whose realization becomes known at t and η_{t+1} is the *corporate risk premium*, with value given as in Bernanke, Gertler, and Gilchrist (1999) by:

$$1 + \eta_{t+1} = F(\frac{Q_t K_{t+1}}{P_t N_t}), F(1) = 1, F'(.) > 0 \tag{3.12}$$

Entrepreneurs collect income from capital and repay foreign debt. They consume a share of $(1 - \delta)$ of the rest in import goods. Their net worth will be given by:

$$P_t N_t = \delta \left(R_t K_t - \Phi_t \alpha P_t Y_t - (1 + \rho_t) S_t D_t \right) \tag{3.13}$$

or in real terms:

$$N_t = \delta\left((1-\Phi_t)\alpha Y_t - (1+\rho_t)E_t D_t\right) \tag{3.14}$$

3.2.2 Public Sector

In period t government collects taxes ($P_t T_t$), and issues on international markets public bonds denominated in foreign currency (B_{t+1}). The government uses these resources to pay debt issued in the previous period (B_t), and to spend G_t on home goods. Public debt pays an interest rate for dollars borrowed between t and $t+1$ (i^G_{t+1}) that it is higher than the safe interest rate (ρ_{t+1}). The dynamics of the sovereign risk (η^G_{t+1}) is specified later.

The government budget constraint is shown in equation 3.15.

$$\frac{S_t B_{t+1}}{(1+\rho_{t+1})(1+\eta^G_{t+1})} + P_t T_t = P_t G_t + B_t S_t \tag{3.15}$$

For the moment we assume ($G_t = 0$).

We describe the government's behaviour by the following equation :

$$B_{t+1} = \overline{B} - \alpha^G(Z_t - \overline{Z}) \tag{3.16}$$

where Z_t is output in dollars ($Z_t \equiv \frac{P_t Y_t}{S_t}$), and $\overline{Z}$ is its steady state value.

This representation encompasses three different types of fiscal policy: : i) Countercyclical fiscal rule ($\alpha^G > 0$, herein FRC); ii) Procyclical fiscal rule ($\alpha^G < 0$, herein FRP); iii) Neutral fiscal rule ($\alpha^G = 0$, herein $FR\overline{B}$).

These fiscal rules are defined in terms of the public debt for analytical convenience. In equation 3.19 we can see the implications in terms of taxes of these fiscal rules.

Although the 3 fiscal rules implies a different behavior in terms of cyclicality of fiscal policy, they all imply that public debt can not be so far from its steady state value, and ensures in this sense, the sustainability of fiscal policy. For example, under FRC, in face of an adverse external shock that provokes an output in dollars below its steady state value, taxes are decreased and public debt is increased but only at a distance $\alpha^G(Z_t - \overline{Z})$ from its steady state value. If the period after the shock Z_{t+1} continues at the same distance from $\overline{Z}$, B_{t+2} can not continue increasing, and so taxes have to increase in order to ensure that (see also equation 3.20 where this "second period effect" can be seen explicitly). A similar reasoning applies, under FRP, after a favorable shock that generates $Z_t > \overline{Z}$. In appendix 3.7.3 we analyze which conditions have to fulfill α^G to preclude explosive dynamics (and in particular of public debt).

As a result, in the cases that are analyzed in this paper, fiscal sustainability is ensured and in this context it is reasonable that sovereign risk does not respond too much to changes in public debt (that as we have seen are close to the steady state level). For simplicity we assume an extreme case where sovereign risk follows an exogenous process:

$$\eta^G_{t+1} = \eta^G + \epsilon^B_{t+1} \tag{3.17}$$

In section 3.5.2 we discuss the consequences of assume that the sovereign risk depends on the level of public debt (see also appendix 3.7.9 at this respect).

In the $FR\overline{B}$ case public debt in dollars is the same each period:

$$B_{t+1} = B_t = \overline{B} \tag{3.18}$$

Combining equation 3.18 with equation 3.15 we arrive to the following condition that taxes have to fulfill each period to ensure that public debt in dollars remains constant.

$$P_t T_t = \frac{\overline{B} S_t i^G_{t+1}}{(1 + i^G_{t+1})} \tag{3.19}$$

where $(1 + i^G_{t+1}) = (1 + \rho_{t+1})(1 + \eta^G_{t+1})$

If we do not restrict $\alpha^G = 0$ (i.e. if we are under FRC or FRP), then taxes evolve each period according to:

$$P_t T_t = \frac{\overline{B} S_t i^G_{t+1}}{(1 + i^G_{t+1})} + \alpha^G S_t \left[\frac{Z_t - \overline{Z}}{(1 + i^G_{t+1})} - (Z_{t-1} - \overline{Z}) \right] \tag{3.20}$$

Dollarized public debt provides another possible rationale to fixed exchange rates. A less volatile exchange rate implies a lower volatility of public debt service, and a lower volatility of taxes. By this channel, fixed exchange rate could induce lower volatility of consumption, an issue that we will discuss in the rest of the paper.

3.3 Equilibrium

In equilibrium the domestic production market clears. This implies,

$$P_t Y_t = \gamma Q_t (K_{t+1} + C_t) + S_t X \tag{3.21}$$

where X are exogenous exports (in dollars).

Log-linearizing the equilibrium equations around a non-stochastic steady state, we can obtain the following law of motion of the corporate risk premium:

$$\begin{aligned} \eta'_{t+1} - \phi \eta'_t \;=\; & \mu \left(\frac{1 - \lambda_k}{\lambda_k} \right) (y_t - e_t) + \\ & \mu \delta (1 + \rho) \psi [(e_t - {}_{t-1}\, e_t) - (y_t - {}_{t-1}\, y_t)] + \\ & \mu \frac{\lambda_b}{\lambda_k} \left[b_t - \left(\frac{b_{t+1} - \rho'_{t+1} - \eta^{G'}_{t+1}}{1 + i^G} \right) \right] \end{aligned} \tag{3.22}$$

where, as in the rest of the paper lowercase letters imply percentage deviations from steady-state values, and ρ', η' and $\eta^{G'}$ are deviations from the respective steady-state levels of these variables. The share of investment demand in total non-consumption demand for home goods net of taxes is represented by $\lambda_k \equiv \frac{\gamma QK}{\gamma(QK - T) + SX}$, and the ratio of public debt (multiplied by γ) to total nonconsumption demand for home goods net of taxes is represented by $\lambda_b \equiv \frac{\gamma S \overline{B}}{\gamma(QK - T) + SX}$. At the same time, ϕ is the persistence of corporate risk premium, μ is the elasticity

of corporate risk premium with respect to capital to net worth ratio and ψ is the corporate debt to net worth ratio.[5]

According to equation 3.22 the change in risk premium can be seen as the sum of three different effects. The first term in the right hand side (RHS) shows that a depreciation decreases risk through its effect on exports, whose value in pesos are increased. Given home output, the increase in the participation of exports in demand displaces investment and implies a decrease in risk. The second term in the RHS is associated with the balance sheet channel, an unexpected devaluation or an unexpected output fall, increases the value of inherited debt with respect to net worth and increases risk. Finally the third term in the RHS is associated with fiscal policy. Given home output, if b_t is higher than $b_{t+1}/(1+i^G)$, this implies that taxes are increasing, and so consumption is decreasing. The decrease in consumption generates more room for investment, and with the same net worth corporate risk has to increase.[6]

Combining equation 3.7.75 in appendix, with a linearized version of equation 3.21 we obtain the evolution of output in dollars.

$$z_{t+1} = \rho'_{t+1} + \eta'_{t+1} + \left[z_t + \lambda_b b_t - \frac{\lambda_b}{1+i^G}(b_{t+1} - \rho'_{t+1} - \eta^{G'}_{t+1}) \right] \frac{1}{\lambda_k} \tag{3.23}$$

where output in dollars is defined as: $z_{t+1} = y_{t+1} - e_{t+1}$

Linearizing equation 3.16 we obtain the following equation that describes the dynamics of public debt according to the fiscal rule

$$b_{t+1} = \frac{-\alpha^G Z}{B} z_t \tag{3.24}$$

The dynamics of the model can be summarized by equations 3.22, 3.23 and 3.24. In the model z_t is a jump variable, while η'_t and b_t are predetermined. In appendix 3.7.1 we show general conditions under which the equilibrium of a system with two predetermined variables and one non-predetermined, is determined. Appendix 3.7.3 checks these conditions in our model. Among these restrictions, we show that, to ensure determinacy, i^G and/or α^G cannot be too big. Intuitively if we have an extreme countercyclical fiscal policy (α^G too big), then we need i^G small, otherwise after an adverse shock, public debt will increase too much, and if the interest rate paid on public debt is high, we may end up with unsustainable public debt dynamics. In the appendix we also show that a determinate equilibrium imposes a limit on the pro-cyclicality of fiscal policy, α^G can not be too negative. We will return to this condition on section 3.4.2, where it is shown numerically that under a strong pro-cyclical fiscal policy the equilibrium is not determined.

In the $FR\overline{B}$ case, $\alpha^G = 0$ and according to equation 3.24: $b_t = b_{t+1} = 0$, and the dynamics are driven by equations 3.22 and 3.23, which are also simplified. Under these conditions, as it is shown in appendix 3.7.3, z_t evolves according to equation 3.25

$$z_t = \xi_\eta \eta'_t \tag{3.25}$$

[5] See appendix 3.7.2 for details.

[6] In the short run, given the assumption of wage rigidity, output could be determined by aggregate demand. In that case, for a given investment, consumption decrease will imply less output and less net worth and so an increase in corporate risk.

where the saddle path coefficient, ξ_η is negative, implying that situations where the risk is below the steady state are associated with situations where output in dollars is above steady state.

In the FRC and FRP cases ($\alpha^G \neq 0$) we have to consider the three equations (3.22, 3.23 and 3.24). Given that this system is saddle-path stable, z_t can be solved as a function of $\eta_t^{'}$ and z_{t-1} as it is shown in equation 3.26.[7]

$$z_t = \xi_z z_{t-1} + \xi_\eta \eta_t^{'} \tag{3.26}$$

It can be shown that ξ_z and ξ_η increase when α^G increases. ξ_z starts from approximately -1 at the most procyclical fiscal policy compatible with determinacy, it is zero in $FR\overline{B}$ and it is approximately 1 at the most countercyclical fiscal policy compatible with determinacy. ξ_η is always negative but it is a big coefficient (in absolute value) at the most procyclical fiscal policy compatible with determinacy and it is close to zero under a strong countercyclical fiscal policy.

3.4 Financial shocks and macroeconomic policies

In this section we analyze the economic response to a financial shock under different policy regimes. The financial shock implies a transitory and unexpected rise of the risk-free interest rate. We start at the steady state. In $t = 0$ the economy suffers a financial shock, $\rho_1^{'}$ rises unexpectedly, the next period ρ returns to steady state level and the system settles on saddle path converging to steady state. We try to see the results in terms of several key macroeconomic variables (output, consumption, exchange rate, investment and others) both analytically and by simulating the model numerically.

We first analyze in section 3.4.1 a benchmark case where exchange rate regime is flexible and fiscal policy is neutral. In section 3.4.2 we discuss how the economic performance changes when fiscal policy is not neutral and exchange rate is not flexible.

3.4.1 The case of flexible exchange rates and neutral fiscal policy

In this section we first define a flexible exchange rate regime and we analyze the implications for the home goods and financial markets equilibrium. As a first step we will not restrict the value of α^G. As in Céspedes, Chang, and Velasco (2004), we will distinguish a situation of financial vulnerability from a robust one. In Section 3.4.1 we will see how the equilibrium in home goods and in financial markets is simplified when α^G is restricted to 0 (the neutral fiscal policy case). Under these conditions we will see the consequences of a financial shock.

A flexible exchange rate regime

A flexible exchange rate regime is defined as one where Central Bank allows s_t to move freely and uses monetary policy in order to target domestic output price level ($_{t-1}p_t = p_t = 0$). Under these conditions, $e_t = s_t - p_t = s_t$ and Céspedes, Chang, and Velasco (2004) show that $l_t = w_t = p_t = 0$.

In any policy regime, the wage setting rule implies:

$$_{t-1}l_t = 0 \tag{3.27}$$

[7] See appendix 3.7.3 for details.

and linearizing eq 3.4 we obtain:

$$y_t - l_t = w_t - p_t \tag{3.28}$$

Using equations 3.21, 3.8 and 3.15, and linearizing we obtain the following version of aggregate demand:

$$y_t = \lambda_k(k_{t+1} + q_t - p_t) + (1-\lambda_k)(s_t - p_t) - \lambda_b b_t + \frac{\lambda_b}{1+i^G}(b_{t+1} - \rho'_{t+1} - \eta^{G'}_{t+1}) \tag{3.29}$$

Linearizing the definition of the price level we arrive to:

$$q_t - p_t = (1-\gamma)e_t \tag{3.30}$$

The linearized version of the production function is:

$$y_t = \alpha k_t + (1-\alpha)l_t \tag{3.31}$$

In period 0, assuming that we are at the steady state and so $k_0 = 0$, combining 3.27 with 3.28 and 3.31 we obtain:

$$y_0 = \left(\frac{1-\alpha}{\alpha}\right) p_0 \tag{3.32}$$

that can be interpreted as a simple Phillips curve.

A regime of flexible exchange rates implies $l_0 = 0$, using $k_0 = 0$ (we start at the steady state), and 3.31, we have: $y_0 = 0$. Combining this with 3.30 and 3.29 we arrive to the following version of the IS:

$$e_0 = \frac{-\lambda_k(1+i^G)B}{(1-\lambda_k\gamma)(1+i^G)B + \lambda_b\alpha^G Z}k_1 + \frac{\lambda_b B}{(1-\lambda_k\gamma)(1+i^G)B + \lambda_b\alpha^G Z}(\rho'_1 + \eta^{G'}_1) \tag{3.33}$$

According to equation 3.33 in order to ensure equilibrium in the home goods market an investment increase has to be associated with an appreciation of the real exchange rate. For a given home output a real exchange rate appreciation increases the dollar value of output, decreases the share of exports in output, and reduces the relative value of investment. This allows the increase in investment. This relationship is affected by the fiscal rule. In the countercyclical case ($\alpha^G > 0$), the appreciation and the resulting increase in output in dollars implies that taxes has to increase, and so consumption decreases. The decrease in e is associated with a decrease in exports and in addition with a decrease in consumption and so to keep equilibrium the investment increase requires less appreciation. In the procyclical case ($\alpha^G < 0$), appreciation will induce a decrease in taxes and an increase in consumption, and the needed appreciation for a given increase in investment will be higher.

In addition, a risk-free interest rate shock (ρ'_1) or a sovereign risk shock ($\eta^{G'}_1$) has to be accompanied by a real exchange rate depreciation (or an increase in investment) in order to keep domestic goods market equilibrium. The fiscal rule can magnify or diminish this effect. In the $FR\overline{B}$ case ($\alpha^G = 0$), both shocks imply an increase in taxes, (see equation 3.19), that decreases consumption (see equation 3.8). An increase in exports (via depreciation) or an investment increase can compensate the fall in consumption. In the countercyclical case ($\alpha^G > 0$), taxes increase

less than what is needed to maintain public debt unchanged and so consumption and the need for the depreciation is also reduced. The opposite happens in the pro-cyclical case ($\alpha^G < 0$).

Linearizing the interest parity condition we have:

$$y_t - (q_0 - p_0) - k_1 = \rho_1^{'} + \eta_1^{'} + e_1 - e_0 \tag{3.34}$$

Equation 3.22, under flexible exchange rates becomes:

$$\begin{aligned} \eta_1^{'} &= \mu \left(\frac{-1+\lambda_k}{\lambda_k} + \delta(1+\rho)\psi - \frac{\alpha^G Y}{QK(1+i^G)} \right) e_0 + \frac{\mu\lambda_b}{\lambda_k(1+i^G)}(\rho_1^{'} + \eta_1^{G'}) \\ &\equiv \epsilon_{\eta e} e_0 + \epsilon_{\eta i^G}(\rho_1^{'} + \eta_1^{G'}) \end{aligned} \tag{3.35}$$

where

$$\epsilon_{\eta e} \equiv \mu \left(\frac{-1+\lambda_k}{\lambda_k} + \delta(1+\rho)\psi - \frac{\alpha^G Y}{QK(1+i^G)} \right) \tag{3.36}$$

is the elasticity of the corporate risk premium with respect to a change in the real exchange rate;[8] and

$$\epsilon_{\eta i^G} \equiv \mu \frac{\lambda_b}{\lambda_k}(1+\rho)^{-1}(1+\eta^G)^{-1} > 0$$

is the elasticity of the corporate risk premium with respect to a change in the interest rate that has to pay sovereign debt.

An increase in the interest rate paid on public debt (via ρ or η^G) increases corporate risk.[9]

As in Céspedes, Chang, and Velasco (2004) we distinguish a situation of financial vulnerability ($\epsilon_{\eta e} > 0$) from a situation of financial robustness ($\epsilon_{\eta e} < 0$). The probability that an economy is in a financially vulnerable situation increases with $\psi = SD/N$ (steady state corporate debt to net worth ratio) and decreases with α^G. A countercyclical fiscal policy ($\alpha^G > 0$) diminishes the probability of being in a vulnerable situation. Imposing $\epsilon_{\eta e} = 0$ in equation 3.36 we arrive to:

$$\alpha^{G*} = \left(\frac{-1+\lambda_k}{\lambda_k} + \delta(1+\rho)\psi \right) \frac{QK(1+i^G)}{Y} \tag{3.37}$$

This α^{G*} gives a threshold from which fiscal policy can change the financial situation given the other parameters. In particular a "large enough" α^G (a "tough enough" countercyclical fiscal policy) can transform, given the other characteristics of the economy, a financially vulnerable situation in a robust one. Alternatively, a "low enough" α^G (a "strong enough" procyclical fiscal policy) can convert a financially robust situation in a vulnerable one.

Combining equation 3.34 with equation 3.35 and equation 3.26 we arrive to:

[8] In the $FR\overline{B}$ case, $\alpha^G = 0$ and so the last term in this expression is zero.

[9] The increase in the interest rate that have to pay public debt implies that taxes has to increase, and consumption has to decrease. In order to keep good market equilibrium investment has to increase and with the same net worth corporate risk increases. In the short run, given the assumption of wage rigidity, output could be determined by aggregate demand. In that case, for a given investment, consumption decrease will imply less output and less net worth and so an increase in corporate risk.

$$e_0 = \frac{1}{\gamma - \xi_z - (1-\xi_\eta)\epsilon_{\eta e}} k_1 + \frac{1 + (1-\xi_\eta)\epsilon_{\eta i^G}}{\gamma - \xi_z - (1-\xi_\eta)\epsilon_{\eta e}} \rho_1^{'} + \frac{(1-\xi_\eta)\epsilon_{\eta i^G}}{\gamma - \xi_z - (1-\xi_\eta)\epsilon_{\eta e}} \eta_1^{G'} \tag{3.38}$$

Equation 3.38 describes the equilibrium conditions in international financial markets, and it is a variant of the "BP" equation of Céspedes, Chang, and Velasco, 2004 with the addition of fiscal policy effects. In the $FR\overline{B}$ case, it can be shown that $\xi_z = 0$ and $\xi_\eta < 0$. In that case we have two effects included in this equation, that affects the relation between depreciation and investment. Firstly, depreciation decreases the cost of investment in dollars (dollar price of domestic production is reduced with depreciation), this implies that in order to keep equilibrium in the loan market an increase of e_0 has to be met with an increase in investment (k_1). The size of this effect increases with the proportion of investment that is made in home goods (γ). There is a second effect, that depends on the sign of $\epsilon_{\eta e}$. In a financially robust economy, where an increase of e_0 decreases η_1 ($\epsilon_{\eta e} < 0$) a depreciation affects positively investment, and so the positive relationship between investment and depreciation is reinforced. This situation is depicted by the left panel of figure 3.1, where the BP curve slopes up in (k_1, e_0) space. The IS curve slopes downwards in the same plane. The situation is different in a financially vulnerable economy where $\epsilon_{\eta e} > 0$. If this second effect is more important than the positive effect of the depreciation in the investment cost (i.e. $\gamma < \xi_z + (1-\xi_\eta)\epsilon_{\eta e}$) then the BP curve slopes down in (k_1, e_0) space, as it is shown by the right panel of figure 3.1.

The relation between the international interest rate and the real exchange rate will also be affected by the sign of $\epsilon_{\eta e}$. In a financially robust economy an increase in the international interest rate has to be met with a depreciation (that decreases corporate risk in this case), in order to keep a equilibrium on financial markets. The opposite holds in the financially vulnerable case.

The equilibrium in the financial markets is also affected by sovereign risk. An increase in sovereign risk, that increases corporate risk as we have seen in equation 3.35, keeping investment constant, has to be combined with a movement of the real exchange rate that decreases corporate risk (a depreciation in a financially robust economy, or an appreciation in a financially vulnerable one).

The neutral fiscal policy case ($FR\overline{B}$, $\alpha^G = 0$)

As we have commented in section 3.3, in the $FR\overline{B}$ case $\xi_z = 0$, and on the saddle path z_t is only function of $\eta_t^{'}$ (see equation 3.25). Given that $\alpha^G = 0$, IS is simplified to:[10]

$$e_0 = \frac{-\lambda_k}{1 - \lambda_k \gamma} k_1 + \frac{\lambda_b}{1 - \lambda_k \gamma (1 + i^G)} (\rho_1^{'} + \eta_1^{G'}) \tag{3.39}$$

The BP is also simplified and becomes:[11]

$$e_0 = \frac{1}{\gamma - (1-\xi_\eta)\epsilon_{\eta e}} k_1 + \frac{1 + (1-\xi_\eta)\epsilon_{\eta i^G}}{\gamma - (1-\xi_\eta)\epsilon_{\eta e}} \rho_1^{'} + \frac{(1-\xi_\eta)\epsilon_{\eta i^G}}{\gamma - (1-\xi_\eta)\epsilon_{\eta e}} \eta_1^{G'} \tag{3.40}$$

[10] In the extreme case where there is no public debt ($\lambda_B = 0$), the second term in the right hand side of 3.39 vanishes and we obtain the same IS as in Céspedes, Chang, and Velasco (2004).

[11] If public debt is zero ($\epsilon_{\eta i^G} = 0$), and equation 3.40 collapses to the same BP as in Céspedes, Chang, and Velasco (2004)

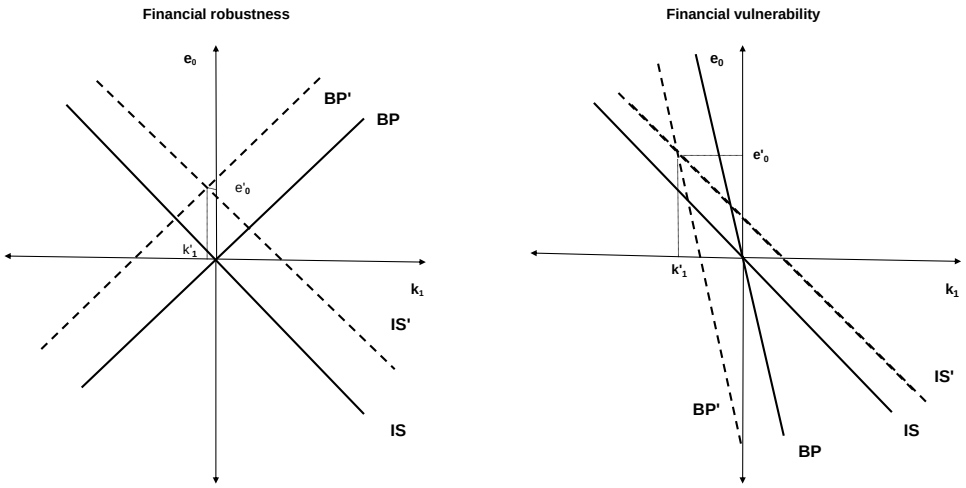


FIGURE 3.1: Financial shock under flexible exchange rate and $FR\overline{B}$ ($\alpha^G = 0$)

If the risk-free interest rate increases ($\rho_1^{'} > 0$), in order to maintain equilibrium in financial markets, investment has to decrease, BP has to move to the left. The increase in ρ affects directly the burden of corporate debt and indirectly via an increase in corporate risk produced by the rise in the interest rate paid on public debt (see equation 3.35). To keep equilibrium, marginal return of capital has to increase (and for the same real exchange rate investment has to decrease). The IS curve moves to the right, because as we have commented, a risk-free interest rate shock has to be accompanied by a real exchange rate depreciation (or an increase in investment) in order to keep domestic goods market equilibrium.

These effects can be seen in figure 3.1 where we depicted the consequences of an unexpected increase of ρ_1 (ρ is supposed to return to its steady state level in the following period). As we can see in the graph, the financial shock implies a real depreciation no matter if the economy is in a vulnerable or in a robust financial situation. Investment is reduced in the vulnerable situation, but the final result is unclear in the robust one (in the graph we assume that investment is reduced also in this case). In order to have an investment decrease after a financial shock in the robust economy the following condition must be satisfied:[12]

$$\lambda_b < \frac{1-\lambda_k\gamma}{\lambda_k\gamma-(1-\xi_\eta)\left[\epsilon_{\eta e}\lambda_k+\mu(1-\lambda_k\gamma)\right]} \equiv \lambda_b^*$$

Real depreciation is higher under a vulnerable situation. In this case the investment decrease is clearly more important, and, to keep equilibrium in good markets, exports (and real exchange rate) have to increase more.

The financial shock does not alter the initial product level (y_0), given that we are in the case of flexible exchange rates $y_0 = l_0 = 0$. The real depreciation ($e_0 > 0$) implies that product in dollars falls on impact ($z_0 < 0$). On the other hand the investment decrease (that clearly happens in the vulnerable case) implies that output has to decrease in $t = 1$ ($y_1 = \alpha k_1 < 0$).

[12] $\lambda_b > \lambda_b^*$ implies that public debt is very big, tax increases a lot after shock and consumption decrease is very important. In such an environment investment has to increase to keep equilibrium in the goods market and also depreciation has to be very important to increase exports and to decrease risk (depreciation reduces risk in the robust situation), compensating the increase in the risk free interest rate and the decrease in capital marginal productivity (due to capital increase).

The increase in ρ and the increase in the exchange rate implies an increase in the burden of the dollarized public debt. Fiscal policy keeps public debt unchanged and so taxes are increased on impact (see equation 3.19). Consumption decreases in the period of shock due to the increase of taxes. These initial effects (increase in taxes and consumption decrease) are magnified in a financially vulnerable economy because real depreciation is higher as we commented. In the period after the shock risk free interest rate returns to equilibrium, exchange rate also tends to converge, and taxes tends to converge also to steady state level. The output decrease translates into a decrease in labor income (see equation 3.4) and a consumption decrease (see equation 3.7).

These initial effects are qualitatively similar in the financially vulnerable and in the financially robust economy (except for investment, as we have seen). After the first period, the process that the economy follows in order to return to the steady state is different in each case. The increase in ρ implies an increase in corporate risk (see equation 3.35). In a financially vulnerable economy these effects are reinforced because the real depreciation also leads to an increase in corporate risk (in equation 3.35: $\epsilon_{\eta e} e_0 > 0$). Product in dollars falls below steady state the period after the shock ($z_1 = \xi \eta_1^{'} < 0$), after that we have a convergence process with z_t, y_t and c_t increasing and η_t decreasing.

In a financially robust economy, the real depreciation leads to a fall in corporate risk premium $\epsilon_{\eta e} e_0 < 0$. Corporate risk premium increases less or eventually falls. In the first case, z_1 is below steady state but closer than in the vulnerable case, and so convergence is easier than in the vulnerable situation. If corporate risk premium falls, then the economy enters in the saddle path with an output in dollars above its steady state level ($z_1 = \xi_\eta \eta_1^{'} > 0$), given that $\xi_\eta < 0$. Output in dollars is above the steady state level already one period after the shock, the economy converges fast to the steady state.

3.4.2 Other exchange rate and fiscal regimes

In this section we analyze how the results of section 3.4.1 change when we consider different fiscal policy rules or different degree of exchange rate flexibility. Some of the results depends on numerical analysis, in section 3.4.2 the benchmark calibration is discussed.

Calibration

In order to facilitate comparability we follow, where possible, the calibration of Céspedes, Chang, and Velasco (2000), with the addition of fiscal parameters calibrated with a similar criterion (basically more risk and more indebtedness in public sector for a vulnerable situation). In table 3.1 we show the values that we use for some key parameters.

We take from Céspedes, Chang, and Velasco (2000), the steady state world interest rate (ρ, that is set to 4 percent in annual terms)[13], the domestic products expenditure share of income ($\gamma = 0.6$) and the capital share in the production of the home good ($\alpha = 0.35$). The value of the capitalists saving rate (δ), the elasiticity of coporate risk premiun with respect to capital to net worth ratio (μ), the ratio of investment to debt (QK/SD) and the corporate risk premium are also taken from

[13]This assumption is standard in the literature, see for example Faraglia et al. (2012) or Uribe and Schmitt-Grohe (2004).

TABLE 3.1: Calibration

Parameter	Robustness	Vulnerability
γ	0.6	0.6
PY	1	1
QK	0.33	0.32
λ	0.32	0.32
ρ	0.04	0.04
η	0.02	0.045
η^G	0.02	0.045
SB/Y	0.2	0.8
QK/SD	6	1
μ	0.11	0.01
δ	0.94	0.92
ϕ	0.96	0.23

Céspedes, Chang, and Velasco (2000), where they are defined consistently to obtain the cases of financial vulnerability and robustness. These values are shown in table 3.1.[14]

Some values are normalized to one, as P or Y. Investment in the steady state (QK) is obtained from the interest parity condition in the SS (equation 3.7.68). The capital in home goods to non-consumption demand net of taxes ratio (λ_k) is obtained from the following expression, obtained from the definition of λ_k:

$$\lambda_k = \frac{\gamma\alpha}{(1-\gamma+\alpha\gamma)(1+\rho)(1+\eta)} \tag{3.41}$$

The persistence of the corporate risk premium is obtained from equation 3.7.77.[15]

In the case of public debt over gdp ratio (SB/Y) we calibrate it using an average between gross public debt over GDP and net public debt over GDP[16] for Uruguay (around 40% in 2012-2014), and we consider half of this a robust situation and double of this a vulnerable situation. For the sovereign risk premium we use the same values as the corporate ones.[17]

In the case of the welfare excercises of section 3.5.2 we need to calibrate other parameters that are explained in that section.

[14]The value for η in the vulnerable case considered in Céspedes, Chang, and Velasco (2004) is 4%, we use a value half point higher in order to have a negative sloped BP. Accordingly the value of QK/SD is here a bit smaller than the 1.2 considered in that paper.

[15]The value of ϕ will crucially depend on the first term of the right hand side of equation 3.7.77 because μ has to be a small parameter in order to have determinacy. Nevertheless to obtain a precise number we calibrate $v/\epsilon_\Delta = 1.25$, given that both v and ϵ_Δ are values between 0 and 1, and v is plausible to be higher than ϵ_Δ.

[16]Given that in our model public sector does not have reserves, the relevant concept could be net public debt. However, reserves are usually invested in safe assets with low returns, so the relevant concept to estimate the taxes needed to serve public debt interests could be gross public debt. As a compromise we use the average of both concepts.

[17]Average sovereign risk premium of Uruguay is 3% over the period that data is available (1994-2020), so our calibration can also be justified as less risk than Uruguay as a robust situation and more risk than Uruguay as a vulnerable situation.

Different fiscal rules ($\alpha^G \neq 0$)

In this section we analyze how the results of the benchmark case described in section 3.4.1 change when we maintain flexible rates but we consider different fiscal policy rules. For analytical convenience, we first analyze the case where fiscal policy is countercyclical ($\alpha^G > 0$). Then we analyze the procyclical case ($\alpha^G < 0$). Finally we generalize the analysis to different degree of reaction to the cycle, allowing α^G to vary from the most procyclical fiscal policy consistent with determinacy to the most countercyclical one.

The counter cyclical fiscal policy case (FRC, $\alpha^G > 0$)

As in the benchmark case, that was discussed in section 3.4.1, the financial shock is associated with an initial real depreciation, that implies that product in dollars falls on impact ($z_0 < 0$). Given that dollar output is lower than its steady state level, fiscal policy allows an initial increase in public debt and as a result, taxes increase less than in the neutral fiscal policy case (if fiscal policy is strongly countercyclical, i.e. α^G is large, taxes can decrease). This different behavior of taxes implies that consumption decreases less or even increases in the initial period.

In home goods market, the lower decrease of consumption implies that the increase in the other demand components (necessary to keep equilibrium) is now smaller. In particular the necessary increase in exports is now lower and so the initial depreciation is also lower. This effect can be seen in equation 3.33, where a higher α^G implies lower increase of e_0 as a response of a financial shock $\rho_1^{'} > 0$.

In financial markets, a higher α^G is associated with a more robust financial situation ($\epsilon_{\eta e}$ decreases with α^G, as can be seen in equation 3.36). This implies that a given e_0 is associated with lower risk when fiscal policy is countercyclical. This effect promotes a lower investment decrease after a financial shock under a countercyclical fiscal policy. This lower investment decrease reinforces the conclusion that the increase in exports (necessary to keep goods market equilibrium) is now lower and so the initial depreciation is lower. This effect can be seen in equation 3.38, where a higher α^G (a lower $\epsilon_{\eta e}$) implies lower increase of e_0 as a response of a financial shock $\rho_1^{'} > 0$.

In home goods market the lower decrease of consumption also implies that there is less room for investment. The final effect in terms of investment is unclear. According to calibration exercises, the investment decrease is higher under financial robustness and lower under financial vulnerability (for α^G large enough).[18]

Public debt service increases but lower than under $FR\overline{B}$ (the increase in ρ is the same but there are less depreciation). This reinforces the lower increase of taxes, and the lower decrease of consumption under FRC.

In the next period, as in $FR\overline{B}$, risk free interest rate returns to equilibrium and exchange rate also tends to converge. However public debt is higher than its steady state level, and dollar output is closer to its steady state level, so public debt has to decrease (see equation 3.16) and taxes has to increase. As a consequence, consumption in the period after the shock is lower under FRC than under $FR\overline{B}$ (now we have an increase in taxes added to the effect of less output). Eventually (with α^G large enough) in a vulnerable situation, k_1 and y_1 decrease less, but the effect of the increase of taxes prevails and c_1 is lower under FRC. In a robust

[18]The changes in the graphical analysis shown in figure 3.1 when fiscal policy is countercyclical can be seen in Appendix 3.7.4.

situation k_1 and y_1 decrease more, and this effect is added to the increase of taxes and so the decrease of c_1 is magnified.

After these initial effects, the convergence to steady state is similar to the $FR\overline{B}$ case. As α^G increases, the periods needed to arrive to steady state increase also.

The Procyclical fiscal policy case (FRP, $\alpha^G < 0$)

Under a procyclical fiscal policy the effects on taxes, consumption and real depreciation of a financial shock discussed previously are quite different. The financial shock, as was analyzed, is associated with an initial real depreciation and a drop in the product in dollars. Given the fiscal rule, see equation 3.16, fiscal policy reacts decreasing public debt and increasing taxes more than in the neutral fiscal policy case. As a result, initial consumption decrease is higher under FRP.

In home goods markets, the higher decrease of consumption promotes a more important increase in exports to keep equilibrium. This implies more initial depreciation.

In financial markets, a lower α^G is associated with a more vulnerable financial situation. This effect promotes a higher investment decrease, after a financial shock under a procyclical fiscal policy. In home goods market the higher decrease of consumption implies that there is more room for investment. This last effect seems to prevail according to calibration exercises. The investment decrease is lower when fiscal policy is procyclical.[19,20]

Under FRP public debt service initially increases more than under $FR\overline{B}$ (the increase in ρ is the same but there are more depreciation). In the next period, public debt is below its steady state level, and dollar output is closer to its steady state level, so public debt has to increase (see equation 3.16) and taxes has to decrease. Consumption in period 1 is higher under FRP due to the decrease of taxes and also because k_1 and y_1 decrease less.

After these initial effects, the convergence to steady state is similar to the other cases. As in FRC, α^G increases (in absolute value) the periods needed to arrive to steady state increase also.

Effects on e_0 and k_1 under different values of α^G

In figure 3.2 we can see the result of the shock in terms of e_0 and k_1 for different values of α^G. To obtain these results we simulate the model numerically, following the calibration commented in section 3.4.2. As can be seen system seems to be more stable under FRC and financial robustness (we have determinacy for more values of α^G in this situation). On the contrary, under a strong pro-cyclical fiscal policy the equilibrium is not determined.

The threshold (α^{G*}) that transforms vulnerability in robustness is not binding under our calibration. An extremely strong countercyclical fiscal policy ($\alpha^G = 26.23$) convert the financially vulnerable environment that we simulate into a robust one, but the equilibrium is not determined for $\alpha^G > 8.5$. In the case of robustness, a procyclical fiscal policy with an $\alpha^G < -0.661$ turn robustness into vulnerability. However, the system is not determined for $\alpha^G < -0.676$, so there is a

[19] The more important real exchange rate depreciation in the period of the shock under FRP translates into a more important real exchange rate appreciation in the period after the shock. This implies that the expected rate of return in dollars is higher under FRP, see equation 3.11, which also promotes more investment.

[20] The changes in the graphical analysis shown in figure 3.1 when fiscal policy is procyclical can be seen in Appendix 3.7.4.

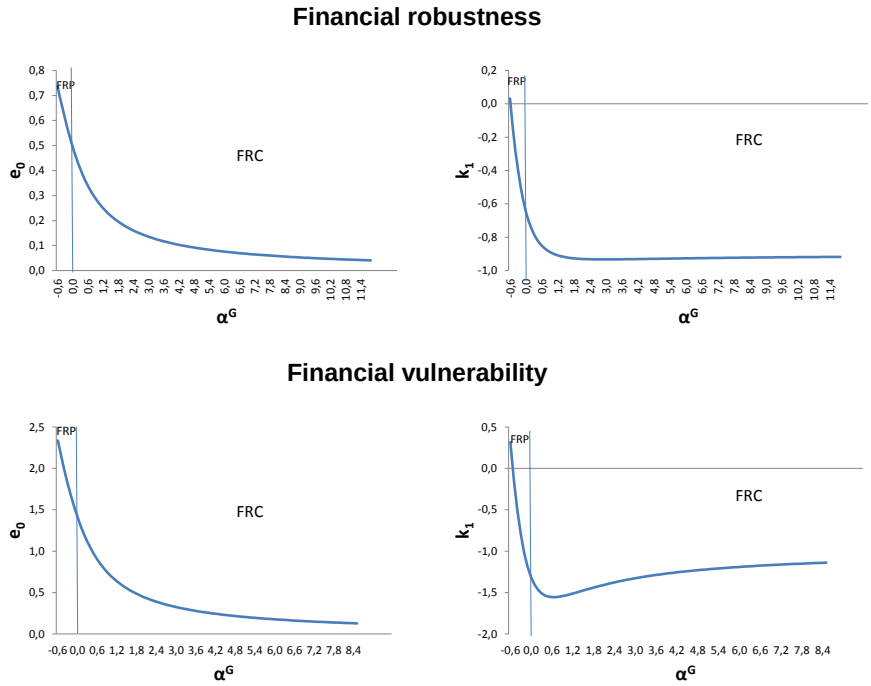


FIGURE 3.2: Financial shock under flexible exchange rate. Effects on e_0 and k_1 of different values of α^G

small parameter space for which we can have a financially robust situation that is changed into a vulnerable one via fiscal policy (keeping the determinacy of the equilibrium).

We can also see that exchange rate depreciation after shock decreases with α^G, procyclical fiscal policy implies more depreciation and countercyclical fiscal policy promotes less depreciation. This result was the most plausible analytically as we have seen previously and seems to be a very robust one.

The maximum investment decrease is reached with a mildly countercyclical fiscal policy while the minimum decrease is obtained with a mildly procyclical fiscal policy. Under vulnerability, we also have that investment decrease is lower with a strong countercyclical fiscal policy compared with a neutral fiscal policy ($\alpha^G > 3,2$ in our simulations).

Both depreciation and investment decrease are magnified by vulnerability. Under vulnerability the increase of ρ is accompanied by an increase in corporate risk premium and so the investment decrease is more important. More investment decrease requires more depreciation in order to keep good markets equilibrium through the increase in exports.

Effects on y_0 and c_0 under different values of α^G

In figure 3.3 we can see the result of the shock in terms of y_0 and c_0 for different values of α^G. Given that we are assuming flexible exchange rates the initial effect on output is zero for all α^G.

Despite this zero initial output effect, consumption decreases on impact under neutral fiscal policy ($\alpha^G = 0$) because of the increase of taxes needed to keep public debt unchanged. Under vulnerability this impact is higher because of a larger depreciation and so the burden of the dollarized public debt is bigger. With $\alpha^G > 0$ (countercyclical fiscal policy) taxes increase less and consumption also decreases less. With an α^G large enough ($\alpha^G > 1$ in robustness or $\alpha^G > 2.3$ in vulnerability)

consumption directly increases in the period of the shock. Under a procyclical fiscal policy $\alpha^G < 0$ the effect goes in the opposite direction.

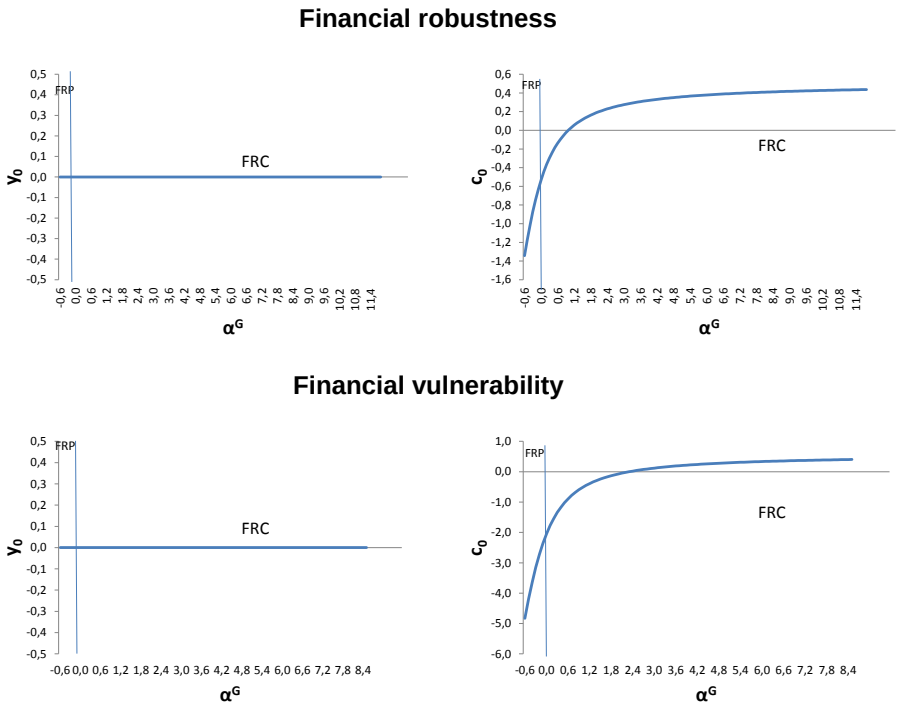


FIGURE 3.3: Financial shock under flexible exchange rate. Effects on y_0 and c_0 of different values of α^G

The dynamics after the shock under different values of α^G

The desirability of each regime has to be not only with the initial effect but also with the economic performance after the shock. In the case of the countercyclical fiscal policy, in the period of the shock, consumption suffers an small reduction, what seems the best solution from the consumer perspective. However, the accumulated public debt implies that taxes in the future have to increase and consumption has to decrease. Moreover investment in the period of the shock is lower under FRC with respect to the procyclical case. This has also implications in terms of future output and consumption.

In Appendix 3.7.5 we show the dynamics of public debt, taxes, output and consumption for 10 periods (the period of the shock and 9 more periods), under the three fiscal policy regimes that we are considering.

Different exchange rate regimes

In this section, for analytical convenience, we first analyze the case where the exchange rate is fixed. After that, we generalize the analysis to different degree of exchange rate flexibility.

Fixed exchange rates

We define a fixed exchange rate regime as one where the Central Bank fixes the nominal exchange rate $s_t = 0$, and so $e_t = -p_t$. The Phillips curve (equation 3.32) now changes to:

$$y_0 = -\left(\frac{1-\alpha}{\alpha}\right) e_0 \tag{3.42}$$

We can obtain the IS as we did for flexible exchange rates. The difference is that now monetary policy does not ensure $y_0 = 0$, instead y_0 is given by 3.42, and so IS will be:

$$e_0 = \frac{-\lambda_k(1+i^G)B\alpha}{(1-\lambda_k\gamma\alpha)(1+i^G)B+\lambda_b\alpha^G Z}k_1 + \frac{\lambda_b B\alpha}{(1-\lambda_k\gamma\alpha)(1+i^G)B+\lambda_b\alpha^G Z}(\rho_1^{'}+\eta_1^{G'}) \tag{3.43}$$

The law of motion of risk premium (equation 3.22), now becomes:

$$\begin{aligned}\eta_1^{'} &= \alpha^{-1}\mu\left(\frac{-1+\lambda_k}{\lambda_k}+\delta(1-\rho)\psi-\frac{\alpha^G Y}{QK(1+i^G)}\right)e_0+\frac{\mu\lambda_b}{\lambda_k(1+i^G)}(\rho_1^{'}+\eta_1^{G'}) \\ &\equiv \alpha^{-1}\epsilon_{\eta e}e_0+\epsilon_{\eta i^G}(\rho_1^{'}+\eta_1^{G'})\end{aligned} \tag{3.44}$$

Equation 3.44 is the same as 3.35 except for the fact that now the effect of a devaluation on risk is amplified by α^{-1} given that under fixed exchange rates a devaluation is associated with deflation, output and net worth decrease and so with more risk.

As in the flexible case we will distinguish a situation of financial vulnerability ($\epsilon_{\eta e} > 0$) from a situation of financial robustness ($\epsilon_{\eta e} < 0$).

Finally, the combination of 3.44 with 3.34 gives the BP in the fixed exchange rates case:

$$\begin{aligned}e_0 &= \frac{1}{\gamma-\xi_z\alpha^{-1}-(1-\xi_\eta)\epsilon_{\eta e}\alpha^{-1}}k_1+\frac{1+(1-\xi_\eta)\epsilon_{\eta i^G}}{\gamma-\xi_z\alpha^{-1}-(1-\xi_\eta)\epsilon_{\eta e}\alpha^{-1}}\rho_1^{'}+ \\ &\quad \frac{(1-\xi_\eta)\epsilon_{\eta i^G}}{\gamma-\xi_z\alpha^{-1}-(1-\xi_\eta)\epsilon_{\eta e}\alpha^{-1}}\eta_1^{G'}\end{aligned} \tag{3.45}$$

In the case of fixed exchange rates combined with a neutral fiscal policy ($\alpha^G = 0$), the graphical analysis based on the IS and BP curves is essentially the same that we showed previously with the only exception that now both curves are flatter than in the flexible case. After a financial shock like the one showed in figure 3.1, investment falls and real exchange rate is depreciated, as happened in the flexible case.

The fall in investment is larger, and the real exchange rate depreciation is lower under fixed rates. There is also an important difference with respect to the flexible counterpart. Under fixed rates the real exchange rate depreciation is associated with price deflation and with a decrease on impact on output and employment, as can be seen in equation 3.42.

The qualitative responses of the system to a shock under fixed exchange rates in the FRC and FRP case are similar to the ones discussed for flexible exchange rates. As we have shown, there is less depreciation in the FRC case, and more depreciation in the FRP case compared with the neutral fiscal policy. This implies that the initial recession is diminished under FRC and amplified under FRP case. The benefits of the counter cyclical fiscal policy are enlarged in the financially vulnerable situation, where the investment decrease is also lower (for α^G large enough) and

so the recession of the following period is also diminished given that the capital decrease is lower.

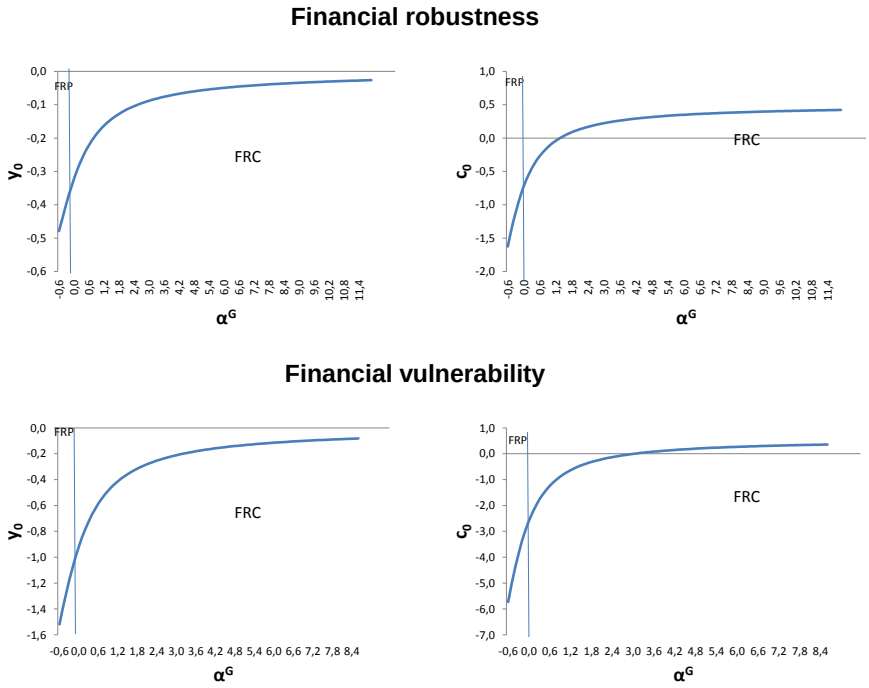


FIGURE 3.4: Financial shock under fixed exchange rate. Effects on y_0 and c_0 of different values of α^G

In figure 3.4 we can see the result of the shock in terms of y_0 and c_0 for different values of α^G. The main difference with figure 3.3 is that output decreases the period of the shock as a result of the nominal rigidity combined with fixed exchange rates. The initial depreciation decreases with α^G, and this translates directly to output (see equation 3.42); the initial recession decreases with α^G. For a very tough countercyclical fiscal policy the initial recession almost vanishes, and we are close to replicate (via fiscal policy) the result of flexible exchange rates.

The burden of the dollarized public debt increases less under fixed exchange rates due to the lower real depreciation under this regime. This puts less pressure on taxes and consequently on consumption. However for a neutral fiscal policy the consumption decrease is higher under fixed exchange rates because the output drop effect prevails. Once again the consumption decrease is more important under FRP and less important under FRC. For an α^G large enough, the initial drop in consumption disappears and consumption eventually increase in the period of the shock.

In Appendix 3.7.6 we show the dynamics of public debt, taxes, output and consumption for 10 periods (the period of the shock and 9 more periods), under the three fiscal policy regimes combined with fixed exchange rates.

Mixed exchange rate regimes

The previous analysis can be generalized by considering that monetary policy can either choose the extreme cases of fixed or flexible exchange rates but also different options in the middle.[21]

[21] See the discussion about the different exchange rate arrangements in Section 3.1.

In order to do this we define an "index of exchange rate flexibility": α^{ER}, that goes from 0 (fixed exchange rate) to 1 (flexible exchange rate).

In this environment Central Bank partly tries to smooth nominal exchange rate fluctuations and partly uses monetary policy to target domestic price level. Domestic price level is given by: $p_t = 0\alpha^{ER} - e_t(1-\alpha^{ER}) = -e_t(1-\alpha^{ER})$; and nominal exchange rate is: $s_t = e_t + p_t = e_t - e_t(1-\alpha^{ER}) = e_t\alpha^{ER}$. By this way, flexible exchange rates ($\alpha^{ER} = 1$, $p_t = 0$, $s_t = e_t$) and fixed exchange rates ($\alpha^{ER} = 0$, $p_t = -e_t$, $s_t = 0$), are two extreme cases of this general definition.

In period 0, Phillips curve is given by:

$$y_0 = -(1-\alpha^{ER})\left(\frac{1-\alpha}{\alpha}\right)e_0 \tag{3.46}$$

The generalized IS curve where y_0 is given by 3.46 is:

$$e_0 = \frac{-\lambda_k(1+i^G)B\alpha k_1 + \lambda_b B\alpha(\rho_1' + \eta_1^{G'})}{-\left[-1+(1-\alpha)\alpha^{ER}\right]\left[(1+i_G)B + \lambda_B\alpha^G Z\right] - (1+i_G)B\alpha\lambda_k\gamma} \tag{3.47}$$

The new law of motion of corporate risk premium is:

$$\begin{aligned}\eta_1' &= \left(\frac{1-\alpha^{ER}(1-\alpha)}{\alpha}\right)\mu\left(\frac{-1+\lambda_k}{\lambda_k} + \delta(1-\rho)\psi - \frac{\alpha^G Y}{QK(1+i^G)}\right)e_0 \\ &+\frac{\mu\lambda_b}{\lambda_k(1+i^G)}(\rho_1' + \eta_1^{G'}) \equiv \left(\frac{1-\alpha^{ER}(1-\alpha)}{\alpha}\right)\epsilon_{\eta e}e_0 + \epsilon_{\eta i^G}(\rho_1' + \eta_1^{G'})\end{aligned} \tag{3.48}$$

As in fixed exchange rates there exists an "amplification effect" (represented by $\frac{1-\alpha^{ER}(1-\alpha)}{\alpha}$) of a devaluation on risk, given that devaluation is partly associated with deflation, output and net worth decrease and so with more risk. The size of this "amplification effect" decreases with α^{ER}.

Also here, $\epsilon_{\eta e} > 0$ implies financial vulnerability, and $\epsilon_{\eta e} < 0$ financial robustness.

The combination of 3.48 with 3.34 gives the BP in these intermediate exchange rate regime:

$$e_0 = \frac{k_1 + \left(1+(1-\xi_\eta)\epsilon_{\eta i^G}\right)\rho_1' + \left((1-\xi_\eta)\epsilon_{\eta i^G}\right)\eta_1^{G'}}{\gamma - \left(\frac{1-\alpha^{ER}(1-\alpha)}{\alpha}\right)\xi_z - (1-\xi_\eta)\epsilon_{\eta e}} \tag{3.49}$$

The dynamic effects of a financial shock under different regimes

In Table 3.2 we show the effects of the financial shock during the period of the shock and the next nine periods under the different financial situations and policy regimes that we are considering. We show the average of consumption losses, the variance of consumption, and the same measures for output. We select five possible values of α^G, the same three that are showed in appendix 3.7.5 and 3.7.6 (-0.4, 0 and 3.5), and two new possible values (-0.6 and 8). We add -0.6 to have an idea of what could be the results of the strongest procyclical fiscal policy consistent with determinacy, and $\alpha^G = 8$ to have an stronger countercyclical fiscal policy. We also consider three possible exchange rate regimes: fixed ($\alpha^{ER} = 0$), flexible ($\alpha^{ER} = 1$) and an intermediate case ($\alpha^{ER} = 0.5$).

TABLE 3.2: Effects on consumption and output of a financial shock

		Financial robustness				Financial vulnerability			
α^{ER}	α^{G}	$\sum c/n$	$\sigma^2{}_c$	$\sum y/n$	$\sigma^2{}_y$	$\sum c/n$	$\sigma^2{}_c$	$\sum y/n$	$\sigma^2{}_y$
0	-0,6	-0,08	1,21	-0,07	0,04	-0,31	11,34	-0,25	0,37
0	-0,4	-0,09	0,25	-0,07	0,02	-0,34	2,72	-0,23	0,18
0	0	-0,09	0,05	-0,06	0,02	-0,32	0,65	-0,18	0,11
0	3,5	-0,07	0,03	-0,04	0,01	-0,27	0,04	-0,09	0,02
0	8	-0,05	0,03	-0,03	0,01	-0,18	0,04	-0,07	0,01
0,5	-0,6	-0,07	1,20	-0,06	0,03	-0,28	11,12	-0,20	0,27
0,5	-0,4	-0,08	0,23	-0,06	0,01	-0,31	2,57	-0,18	0,10
0,5	0	-0,08	0,05	-0,05	0,01	-0,30	0,58	-0,15	0,07
0,5	3,5	-0,07	0,03	-0,04	0,01	-0,26	0,05	-0,09	0,02
0,5	8	-0,05	0,03	-0,03	0,01	-0,17	0,04	-0,07	0,01
1	-0,6	-0,04	1,15	-0,01	0,02	-0,20	10,54	-0,06	0,16
1	-0,4	-0,06	0,20	-0,02	0,00	-0,24	2,17	-0,06	0,02
1	0	-0,06	0,03	-0,02	0,00	-0,25	0,41	-0,07	0,02
1	3,5	-0,07	0,03	-0,03	0,01	-0,25	0,05	-0,07	0,02
1	8	-0,05	0,03	-0,03	0,01	-0,17	0,05	-0,06	0,01

One thing that emerges clearly from the table is that for the same financial situation and for the same α^{ER}, the performance in the four criteria that we show is always better under a countercyclical fiscal policy. The only exception is in a robust situation under flexible exchange rates, where the performance of the procyclical fiscal policy is similar to the countercyclical counterpart, according to some criteria.

If fiscal policy is procyclical or neutral, for the same financial situation, flexible rates seems to behave better than fixed.

In the case of a countercyclical fiscal policy the choice of the exchange rate regime does not seem to be an important issue. However under a strong countercyclical fiscal policy ($\alpha^{G} = 8$ in the example) the combination with a fixed exchange rate seems to have some minor advantages. Fixed exchange rates contribute to stabilize the dollarized public debt and for the same financial situation and cyclicality of fiscal policy, taxes paid after the financial shock are lower under fixed exchange rate (see appendix 3.7.7). This has a beneficial effect on consumption but, when fiscal policy is not countercyclical enough, it is more than compensated by the negative output effects associated to the shock under fixed rates. Nevertheless, when fiscal policy is sufficiently countercyclical, output effects are not important, and the advantages of lower taxes under fix rates prevail.

Finally the procyclical fiscal policy implies in all the cases more consumption volatility than the neutral fiscal policy, but can have some benefits in terms of lower output and consumption losses, especially when we are in a robust and/or flexible rates environment.

3.5 Welfare analysis

3.5.1 Optimality of flexible exchange rates in the neutral fiscal policy case

Céspedes, Chang, and Velasco (2004) shows that in a dollarized economy with nominal and financial frictions flexible exchange rates dominates fixed exchange rates from a welfare point of view. Here we show that when we add a dollarized public debt, in a neutral fiscal regime ($\alpha^{G} = 0$), this conclusion remains.

Entrepreneurial consumption (and so welfare) does not depend on monetary policy, so monetary policy have to concentrate in maximize workers utility. The

utility of workers depends on consumption, which is equal to disposable income. We are assuming that $\alpha^G = 0$, and so taxes are given by equation 3.19. Substituting this and the first order condition for labor (equation 3.4) in equation 3.8, consumption can be expressed as:

$$C_t = \frac{(1-\alpha)P_t Y_t}{Q_t} - \frac{\overline{B} S_t i^G_{t+1}}{(1+i^G_{t+1})Q_t} \tag{3.50}$$

Using the definition of Q_t, E_t, Z_t and rearranging we arrive to:

$$C_t = Y_t^{\gamma} Z_t^{-\gamma} \left((1-\alpha) Z_t - \frac{\overline{B} i^G_{t+1}}{(1+i^G_{t+1})} \right) \tag{3.51}$$

Monetary policy has no effect on Z and can affect consumption only through its effect on Y. Output itself depends on employment and on the capital stock. As shown in Céspedes, Chang, and Velasco (2004), the capital stock depends on previous employment levels plus other terms irrelevant for monetary policy. Hence, the maximization of discounted expected consumption implies the maximization of discounted expected output and the maximization of a linear combination of expected labor, that are maximized by flexible exchange rates. Thus, in the special case under consideration ($\alpha^G = 0$), flexible exchange rate regime is the optimal one, despite the effect of nominal exchange rate fluctuations on taxes.

3.5.2 Optimal fiscal and exchange rate policies

Here we consider, more generally, the possibility that α^G can be different from zero, and the possibility that α^{ER} can adopt values from zero to one, and not only the extreme cases of strict flexible or fixed exchange rates.

As we show in appendix 3.7.8 a second order approximation to the utility of the representative consumer, expressed as a fraction of steady state consumption, can be written as:

$$W = E_0 \sum_{t=0}^{\infty} \beta^t \left[\left(c_{it} + \frac{1-\varsigma}{2} c_{it}^2 \right) - (1-\alpha) \frac{Y}{C} \left(l_{it} + \frac{v}{2} l_{it}^2 \right) \right] \tag{3.52}$$

If we take unconditional expectations on equation 3.52 and letting $\beta \longrightarrow 1$, the expected welfare losses can be written:

$$L = (1-\alpha) \frac{Y}{C} \left[avg(l_t) + \frac{v}{2} var(l_t) \right] - \left[avg(c_t) + \frac{1-\varsigma}{2} var(c_t) \right] \tag{3.53}$$

According to equation 3.53 larger labor level and volatility imply more disutility for the representative consumer, who also experiments welfare losses for lower consumption and for more consumption volatility (provided that $\varsigma > 1$).

Optimality under the baseline specification

Table 3.3 reports the optimal combination of fiscal and exchange rate regime for a vulnerable financial situation and for a robust financial situation, and the correspondent welfare losses.

A financial shock is simulated for each exchange rate regime, each financial situation and each fiscal regime, we compute the behavior of the system the period

TABLE 3.3: Optimal combination of policies

	α^{ER}	α^{G}	Welfare losses
Vulnerable	0	8.4	0.16
Robust	0	11.7	0.03

of the shock and 9 more periods, we compute different moments of the variables and the welfare losses associated to each policy combination. Finally, we select the optimal combination, as the one that minimizes this welfare losses. We consider 26 exchange rate regimes. The first regime is $\alpha^{ER} = 0$ (fixed exchange rate regime), α^{ER} is increasing by 0.04 until it reaches $\alpha^{ER} = 1$ (flexible exchange rate regime). For the vulnerable situation we consider 31 fiscal regimes (starting from $\alpha^{G} = -0.6$, increasing by 0.3 until it reaches $\alpha^{G} = 8.4$). For the robust situation we consider 42 fiscal regimes (starting from $\alpha^{G} = -0.6$, α^{G} is increasing by 0.3 until it reaches $\alpha^{G} = 11.7$).[22] We compute the welfare losses associated to each combination of policies in the case of a financial shock, and we select the one that minimizes these losses.

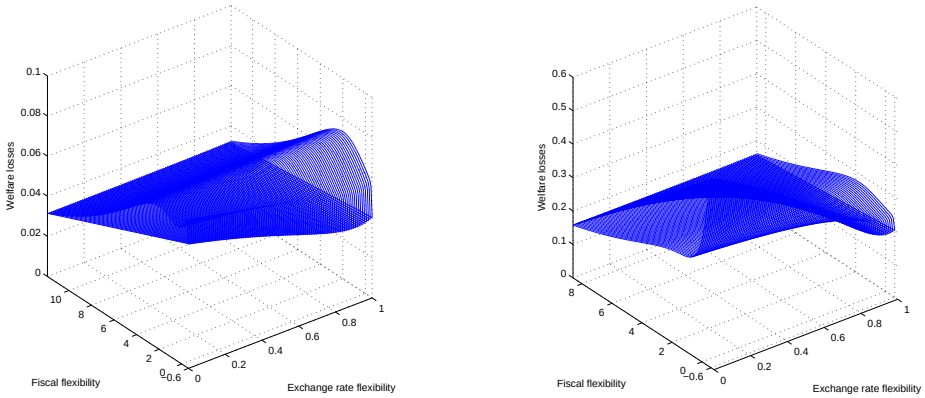
In the baseline case we have log consumption utility ($\varsigma = 1$ in equation 3.53), as it is standard in the literature, the elasticity of labor supply is 2 ($v = 2$; similar value is used in Adolfson et al. (2008)), the discount rate is given by the steady state level of the free-risk discount rate ($\beta = \frac{1}{1+\rho}$), and there is no interaction between the public debt level and sovereign risk ($\mu^{G} = 0$). The optimal combination of policies in this case implies a strong countercyclical fiscal policy and fixed exchange rate.

The option for a countercyclical fiscal policy seems to be a very strong one. Given the exchange rate regime, a countercyclical fiscal policy implies lower consumption losses and lower consumption volatility in the face of a financial shock. It also implies lower output and labor losses and lower output and labor volatility. As we have explained lower labor implies lower disutility but this is a second order effect compared with the others. Given the choice of a countercyclical fiscal policy the choice of the exchange rate regime seems to be of minor importance. The welfare losses implied by the different exchange rate regimes (assuming a countercyclical fiscal policy) are very similar.

However in the baseline specification under a strong a countercyclical fiscal policy, the welfare losses implied by a fixed exchange rate regime are a bit lower. Fixed rates contribute to stabilize the burden of the dollarized public debt and taxes after a shock are lower. Moreover, when fiscal policy is countercyclical enough, the negative output effects associated with fixed rates are not important, and the advantages of lower taxes (associated with more consumption) determine a slightly lower welfare losses.

These effects as we have mentioned are second order ones. In the baseline specification if a countercyclical fiscal policy is a feasible option the choice of the exchange rate regime is a rather irrelevant discussion.

[22] We performed the same exercise considering more exchange rate regimes and more fiscal regimes, (α^{ER} increasing by 0.01, and α^{G} increasing by 0.1) with similar results.



(A) Financial Robustness (B) Financial Vulnerability

FIGURE 3.5: Welfare losses associated with each policy combination

As can be seen in figure 3.5 the welfare losses attain a minimum for a strong countercyclical fiscal policy (represented by high values of α_G, that are interpreted as high values of fiscal flexibility), the welfare losses associated to this strong countercyclical fiscal policy are very similar for the different exchange rate regimes, with a slight advantage for the fixed exchange rate, as we have commented. Welfare losses increase as fiscal policy becomes less countercyclical, differences between exchange rate regimes become more important and lower welfare losses are associated with more flexible exchange rate regimes.

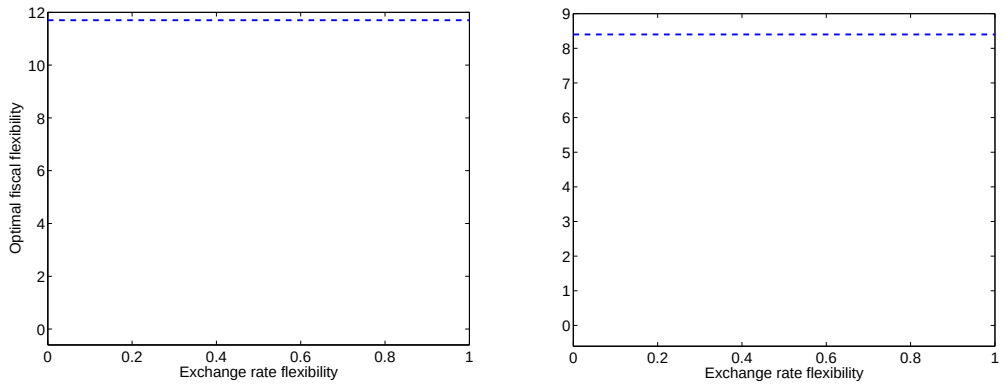
The welfare losses are higher in the vulnerable case compared to the robust situation. The idea that when fiscal policy becomes less countercyclical, differences between exchange rate regimes become more important is also clearer in the vulnerable case.

The conclusion that a countercyclical fiscal policy is the optimal one, with independence of the exchange rate regime becomes more clear in figure 3.6. The graph shows for the robust financial situation (left panel) and for the vulnerable situation (right panel) the optimal fiscal policy given the exchange rate regime. In all the cases a strong countercyclical fiscal policy is optimal.

The analysis of the optimal fiscal policy given the exchange rate regime could be relevant for different reasons. In particular, the institutional framework can limit the choice of the exchange rate regime, as happens in a monetary union where small economies must keep a fix rate with central countries (e.g. euro area). It can also happen that a country decides to keep a rigid exchange rate regime like fixed rates or full dollarization for credibility issues (e.g. Ecuador, Bolivia and other Latin American countries).[23]

Restrictions may also exist with regard to the fiscal regime. For example a country can have difficulties to implement a clear countercyclical fiscal policy (see the

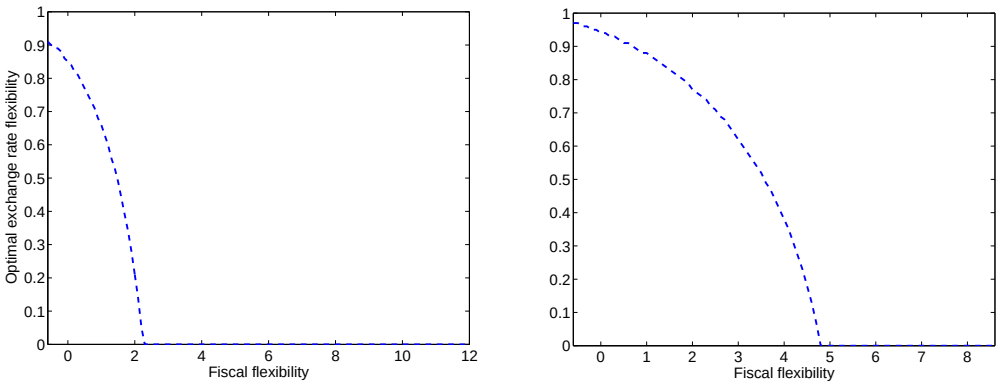
[23]Remember that as we discussed in the Introduction, between 30% and 50% of world GDP is classified in the more rigid categories.



(A) Financial Robustness (B) Financial Vulnerability

FIGURE 3.6: Optimal fiscal flexibility given exchange rate flexibility

evidence on procyclical fiscal polices on emerging economies reported in the introduction). In this case it could be interesting to analysze the optimal exchange rate regime given fiscal policy. In figure 3.7 it can be seen that fixed rates are optimal when fiscal policy is countercyclical enough. However, after a threshold, as fiscal policy becomes less countercyclical, a more flexible exchange rate is preferred. Finally, when fiscal policy is procyclical the optimal exchange rate regime is a very flexible one. In particular the graph shows a result consistent with the analytical results of section 3.5.1: under a neutral fiscal policy, flexible rates are preferable to fixed ones.



(A) Financial Robustness (B) Financial Vulnerability

FIGURE 3.7: Optimal exchange rate flexibility given fiscal flexibility

Optimality under other specifications

Table 3.4 reports the optimal combination of fiscal and exchange rate regime under different specifications.

There are six panels in this table. The top panel reports the optimal combination in the case of the benchmark parametrization (that we have already seen in table 3.3), while the remaining five panels display the effects of altering some values of the baseline calibration.

Higher discount rate

As can be seen in the table, if in the discount rate we add the risk premium to the free-risk interest rate ($\beta = \frac{1}{1+\rho+\eta}$), the conclusion about the optimal policy combination remains unchanged.

Low elasticity of labor supply

In the third panel we can see the effects of assuming lower elasticity of labor supply ($\upsilon = 10$; a similar exercise is made in Galí and Monacelli (2005)). This case implies a larger penalization of labor volatility. Given that fixed exchange rates are associated with more labor volatility, a more flexible exchange rate regime is desirable. After a threshold of α^{ER}, the gains of increasing the exchange rate flexibility are rather irrelevant, so the optimal combination not necessarily implies a complete flexible exchange rate regime ($\alpha^{ER} = 0.84$ in a vulnerable situation and $\alpha^{ER} = 0.44$ in a robust situation). Nevertheless, the conclusion about the optimality of a countercyclical fiscal policy remains.

High relative risk aversion

According to the evidence reported in Gomme and Lkhagvasuren (2013) the parameter ς is positive and no higher than 10; the standard approach is using consumption log utility ($\varsigma = 1$) as we did. Here, we assume that the representative consumer has more relative risk aversion, and to do so we use the highest value consistent with the empirical literature ($\varsigma = 10$). In this alternative, the consumption volatility has a very important penalization.

In the vulnerable situation fixed exchange rates (given that fiscal policy is countercyclical) generates lower tax and consumption volatility, so the benchmark optimal combination is selected again.

In the robust situation, debt and taxes are lower and the stabilizing effect of fixed exchange rates over consumption via a more stable peso value of debt and taxes are less important. Consumption volatility is lower under flexible exchange rates and a milder countercyclical fiscal policy. The optimal combination in this case is: $\alpha^{ER} = 1$ and $\alpha^{G} = 0.03$.

Endogenous sovereign risk

In the last two panels we assume that sovereign risk instead of an exogenous process follow this dynamics:[24]

$$\eta_{t+1}^{G'} = \mu^{G} \frac{B}{Z}(b_{t+1} - z_t) \tag{3.54}$$

[24]See appendix 3.7.9 for details about the derivation of this law of motion of the sovereign risk, and about the changes that introduce in other key equations.

TABLE 3.4: Optimal combination of policies

	α^{ER}	α^{G}	Welfare losses
Benchmark $\varsigma = 1, \upsilon = 2, \beta = \frac{1}{1+\rho}, \mu^G = 0$			
Vulnerable	0	8.4	0.16
Robust	0	11.7	0.03
Higher discount rate $\varsigma = 1, \upsilon = 2, \beta = \frac{1}{1+\rho+\eta}, \mu^G = 0$			
Vulnerable	0	8.4	0.13
Robust	0	11.7	0.03
Low elasticity labor supply $\varsigma = 1, \upsilon = 10, \beta = \frac{1}{1+\rho}, \mu^G = 0$			
Vulnerable	0.84	8.4	0.16
Robust	0.44	11.7	0.03
High relative risk aversion $\varsigma = 10, \upsilon = 2, \beta = \frac{1}{1+\rho}, \mu^G = 0$			
Vulnerable	0	8.4	0.34
Robust	1	0.3	0.15
Endogenous sovereign risk I $\varsigma = 1, \upsilon = 2, \beta = \frac{1}{1+\rho}, \mu^G = 0.01$			
Vulnerable	0	7.8	0.18
Robust	0	11.4	0.03
Endogenous sovereign risk II $\varsigma = 1, \upsilon = 2, \beta = \frac{1}{1+\rho}, \mu^G = 0.02$			
Vulnerable	0.96	-0.6	0.20
Robust	0	11.1	0.03

To calibrate μ^G we use 0.01 and 0.02, these two values are consistent with estimations made for the Uruguayan economy, reported in Basal et al. (2016). As can be seen in the table these new dynamics imply that the optimal combination is basically the same when $\mu^G = 0.01$, and when $\mu^G = 0.02$ and the financial situation is robust.[25] However when $\mu^G = 0.02$ and the financial situation is vulnerable, the optimal combination is a procyclical fiscal policy combined with a highly flexible exchange rate. Financial vulnerability combined with $\mu^G = 0.02$ implies that sovereign risk is more sensitive to changes in the public debt to gdp ratio, and debt burden is very important, so a procyclical fiscal policy has some advantages. This fiscal policy implies that public debt decreases at the moment of the shock and so the increase in the sovereign risk is reduced. Although this is at the expense of higher taxes and lower consumption at the moment of the shock, the lower sovereign risk and public debt generate lower taxes on average and by this way induce more consumption on average. The highly flexible exchange rate helps to avoid higher output (and consumption) losses. The welfare losses in this option are similar to combinations that include a countercyclical fiscal policy. Considering the ten combinations that have the lowest welfare losses, the other nine options includes a countercyclical fiscal policy, see appendix 3.7.10. However represents a case when a procyclical fiscal policy can have some advantages.

[25] The only change is that now the higher feasible α^G is a bit lower.

Some remarks

In the majority of the cases that we reviewed, the conclusion that the optimal policy combination includes a countercyclical fiscal policy remains unchanged. The option for a clear countercyclical fiscal policy seems to be a very strong one, also considering other specifications. We have seen in this section only two exceptions. One where the preferred fiscal policy was mildly countercyclical, and other where it was procyclical (in this case the other nine combinations with lowest welfare losses includes a strong countercyclical fiscal policy). In the two cases, the optimal combination includes a flexible exchange rate, so the conclusion that a more flexible exchange rate policy seems to be required if fiscal policy is less countercyclical also remains. In particular, while in some cases is optimal a countercyclical fiscal policy combined with a flexible exchange rate, under no circumstances is optimal a procyclical fiscal policy combined with fixed exchange rates.

3.5.3 Optimality of countercyclical fiscal policy

In our previous analysis we have seen that a countercyclical fiscal policy is clearly optimal. Here, we discuss some possible explanations of this optimal behavior.

There are four crucial market imperfections in our framework: i) wages are rigid, ii) households have no access to credit markets, iii) entrepreneurs borrow abroad in foreign currency, and this borrowing process is subject to frictions, and iv) government also borrow abroad in dollars through a non-state contingent bond.

A flexible exchange rate regime can deal with the inefficiency generated by sticky wages, while a fixed one can help to mitigate the liability dollarization problem. The exchange rate tool, however, cannot improve the problems originated in the second friction listed above.

A countercyclical fiscal policy can help households to do what they would do if they have the means to do it (smoth consumption). Given the results obtained in section 3.5.2, it seems that alleviating this friction is more relevant in welfare terms that mitigating the others.

3.6 Conclusions

In this paper we analyze the optimal design of exchange-rate policy in tandem with the optimal degree of fiscal cyclicality, in the context of nominal rigidities, financial frictions and liability dollarization. In particular, we extend the work by Céspedes, Chang, and Velasco (2004) to incorporate the fiscal side of the government, assuming that the government also suffers a liability dollarization problem. We also allow mixed exchange rate regimes.

The results highlight the first-order relevance of countercyclical fiscal policies. The exchange rate regime is important only if cyclicality of fiscal policy is suboptimal. A flexible exchange rate policy seems to be required if fiscal policy is not sufficiently countercyclical.

In our model the basic fiscal instrument is lump-sum taxes/transfers. Although other policy instruments can be considered, our paper complements results obtained in the literature. One example is the so called "fiscal devaluations" literature.[26] In these studies, financial frictions and liability dollarization are usually not considered. They concentrate on one specific combination of macroeconomic

[26]See for example the already cited work of Farhi, Gita, and Itskhoki (2014).

policies: a fixed exchange rate combined with a fiscal policy that tries to replicate the results of nominal exchange rate depreciation. Our paper places this combination in a broader perspective.

The same point can be made with respect to studies that analyze the use of capital controls to deal with financial frictions and liability dollarization.[27] In these papers the government budget constraint is not a relevant issue. Our paper by focusing on the desired degree of fiscal cyclicality and exchange rate flexibility complements this literature.

[27] See the work of Kitano and Takaku (2020) as an example of this literature.

3.7 Appendix

3.7.1 Determinacy of equilibrium. The case of two predetermined variables and one non predetermined[28]

Given the following rational-expectations model:

$$\begin{bmatrix} E_t z_{t+1} \\ x_{t+1} \end{bmatrix} = A \begin{bmatrix} z_t \\ x_t \end{bmatrix} + a e_t$$

where z_t is a single non predetermined endogenous state variables, x_t is a 2-vector of predetermined endogenous state variables, e_t is a vector of exogenous disturbances terms, and A is a 3x3 matrix of coefficients. Under this conditions, rational-expectations equilibrium is determinate if and only if the matrix A has exactly two eigenvalues inside the unit circle (i.e. $|\varphi| < 1$), and the other outside the unit circle.

Considering the following characteristic equation of matrix A:

$$P(\varphi) \equiv \varphi^3 + A_2\varphi^2 + A_1\varphi + A_0 = 0$$

This equation has two roots inside the unit circle and one outside if and only if:

either (Case I)

$$P(1) = 1 + A_2 + A_1 + A_0 > 0 \tag{3.7.55}$$

and

$$P(-1) = -1 + A_2 - A_1 + A_0 > 0 \tag{3.7.56}$$

and

$$A_0^2 - A_0A_2 + A_1 - 1 < 0 \tag{3.7.57}$$

or (Case II)

$$P(1) = 1 + A_2 + A_1 + A_0 < 0 \tag{3.7.58}$$

$$P(-1) = -1 + A_2 - A_1 + A_0 < 0 \tag{3.7.59}$$

and condition 3.7.57 holds

or (Case III) conditions 3.7.55 and 3.7.56 holds and

$$|A_0| < 1 \tag{3.7.60}$$

[28]The proof developed in this section is similar to the proof of Proposition C.2, Appendix C of Woodford (2003), where the case of two non predetermined variables and one predetermined is analyzed.

or (Case IV) conditions 3.7.58, 3.7.59 and 3.7.60 holds

Proof:

Case I: We have $P(1) > 0$, $P(-1) > 0$, $P(\lambda) < 0$, when $\lambda \to -\infty$ and $P(\lambda) > 0$, when $\lambda \to \infty$. By continuity there are an even number of real roots between -1 and 1 (0 or 2 real roots), and an odd number of real roots (1 or 3 real roots) lower than -1 and an even number of real roots greater than 1 (0 or 2 real roots).

We have to discard the case of 0 real roots between -1 and 1. Condition 3.7.57 can also be written as:

$$(\lambda_1\lambda_2 - 1)(\lambda_1\lambda_3 - 1)(\lambda_2\lambda_3 - 1) < 0 \tag{3.7.61}$$

In order to have 0 real roots between -1 and 1, we need: a) 3 real roots lower than -1 or: b) 1 real root lower than -1 and two real roots greater than 1. In both cases it is easy to see that 3.7.61 does not hold. This implies that we have two real roots inside the unit circle and one outside.

Case II: The proof is similar to case I. By continuity there are an even number of real roots lower than -1 (0 or 2 real roots), an even number of real roots between -1 and 1 (0 or 2 real roots), and an odd number of real roots greater than 1 (1 or 3 real roots). Again we can discard the case of 0 real roots between -1 and 1, using condition 3.7.57, so we have determinacy also in this case.

The proof of cases III and IV are also similar. We also have to discard the case of 0 real roots between -1 and 1 and condition 3.7.60 can be written as:

$$|-\lambda_1\lambda_2\lambda_3| < 1 \tag{3.7.62}$$

But for 3.7.62 to hold we need at least one $|\lambda| < 1$ so we have two real roots inside the unit circle and one outside.

3.7.2 Corporate risk premium and Steady State

The problem that generates a corporate risk premium in our model is the same as in Céspedes, Chang, and Velasco (2004) and Bernanke, Gertler, and Gilchrist (1999).

Entrepreneurs finance their investment using their net worth($P_t N_t$) and borrowing from foreign lenders in dollars in international markets. Entrepreneurs and lenders are risk neutral.

Credit market frictions determines the appearance of an external finance premium.

Investment generates $\omega^j_{t+1} K^j_{t+1}(R_{t+1}/S_{t+1})$ next period, where ω is a random shock with a known distribution. ω has a mean value of one, it is observed freely by the entrepreneur but lender has to pay a monitor cost of $\zeta\omega^j_{t+1} K^j_{t+1}(R_{t+1}/S_{t+1})$, in order to observe it. If the realization of ω is low and entrepreneur can not pay what was stipulated ($\omega < \bar{\omega}$) then the lender pays the monitor costs and all the product goes to the lender.

In these conditions Céspedes, Chang, and Velasco (2004) show that:

$$1 + \eta_{t+1} = \frac{R_{t+1} S_t}{Q_t S_{t+1}(1 + \rho_{t+1})} \tag{3.7.63}$$

where η is the external finance premium (risk premium), that depends on $\bar{\omega}$

$$1 + \eta_{t+1} = \Delta(\bar{\omega}) \tag{3.7.64}$$

Monitoring costs of equation 3.13 are given by:

$$\zeta \int_0^{\bar{\omega}} \omega^j_{t+1} dH(\omega^j_{t+1}) \equiv \Phi(1 + \eta_{t+1}) \tag{3.7.65}$$

The only difference between our case and the one of Céspedes, Chang, and Velasco (2004) is that in our model we have a public sector. Public expenditure is part of aggregate demand which can affect product level (and net worth) or investment level. Workers have to pay taxes, and so consumption and aggregate demand is decreased.

The proof of the existence of a non-stochastic steady state is similar to the one of Appendix B of Céspedes, Chang, and Velasco (2004). They show, following Bernanke, Gertler, and Gilchrist (1999), that provided that $0 < \delta(1 + \rho) < 1$, there exists a unique positive steady state solution of $\bar{\omega}$, that pins down the values of η and $\frac{QK}{N}$. The steady state values of the other variables can be obtained using the following equations:

$$Y = AK^{\alpha} \tag{3.7.66}$$

$$Q = S^{1-\gamma} \tag{3.7.67}$$

$$\frac{\alpha Y}{QK} = (1 + \rho)(1 + \eta) \tag{3.7.68}$$

$$N + SD = QK \tag{3.7.69}$$

$$Y = \gamma\left[(1 - \alpha)Y + QK - T\right] + SX \tag{3.7.70}$$

$$B = \overline{B} \tag{3.7.71}$$

$$T = \frac{BSi^G}{(1+i^G)} \tag{3.7.72}$$

$$1 + i^G = (1+\rho)(1+\eta^G) \tag{3.7.73}$$

$$\eta^G = \overline{\eta^G} \tag{3.7.74}$$

Combining equations 3.11 and 3.3, and linearizing we arrive to:

$$_{t-1}y_t - (q_t - p_t) - k_{t+1} = \rho'_{t+1} + \eta'_{t+1} +_t (s_{t+1} - p_{t+1}) - (s_t - p_t) \tag{3.7.75}$$

Linearizing equation 3.12, combining with the linearized version of 3.13, and the linearized version of 3.10 and with equations 3.7.64, 3.7.65, 3.7.75 and 3.7.68 and operating we arrive to:

$$\begin{aligned} \eta'_{t+1} \quad = \quad & \phi\eta'_t + \mu(q_t - p_t + k_{t+1} - y_t) + \\ & \mu\delta(1+\rho)\psi[(s_t - p_t) -_{t-1} (s_t - p_t) - (y_t -_{t-1} y_t)] \end{aligned} \tag{3.7.76}$$

where the persistence of the risk premium, ϕ, is:

$$\phi = \delta(1+\rho)(1-\psi\mu) + \mu\left[\delta(1+\rho)(1+\psi)\eta + \delta(1+\rho) - 1\right](\frac{\upsilon}{\epsilon_\Delta}). \tag{3.7.77}$$

We define υ and ϵ_Δ in the same way as Céspedes, Chang, and Velasco (2004).[29]

Now, combining equation 3.29 with equation 3.7.75 we obtain equation 3.34, and using again equation 3.29 combined with 3.7.76 we have 3.22.

[29] υ is the elasticity of $\int_0^{\bar{\omega}} \omega^j_{t+1} dH(\omega^j_{t+1})$ and ϵ_Δ is the elasticity of Δ in 3.7.64, both with respect to $\bar{\omega}$

3.7.3 Steady State. determinacy of equilibrium

In the $FR\overline{B}$ case the the dynamics of the model can be summarized by equations 3.22 and 3.23 (that are simplified given that $\alpha^G = 0$). Assuming no shocks ($\rho'_{t+1} = \eta^{G'}_{t+1} = 0$), these equations can be written in state space form:[30]

$$\begin{bmatrix} z_{t+1} \\ \eta'_{t+1} \end{bmatrix} = \begin{bmatrix} \lambda_k^{-1} + \mu\left(\frac{1-\lambda_k}{\lambda_k}\right) & \phi \\ \mu\left(\frac{1-\lambda_k}{\lambda_k}\right) & \phi \end{bmatrix} \begin{bmatrix} z_t \\ \eta'_t \end{bmatrix}$$

Eigenvalues are real if: $[(1+\mu)(1-\lambda_k) + (1+\phi)\lambda_k]^2 > 4\lambda_k\phi$.

A sufficient conditions for the two eigenvalues to be on opposite sides of the unit circle is: $\phi < 1 + \mu$

Finally we compute the saddle path: $z_t = \xi\eta'_t$, where $\xi = \frac{\lambda_k}{\mu(1-\lambda_k)}(\varphi_2 - \phi)$, where φ_2 is the smaller eigenvalue. We can show that $\varphi_2 - \phi$ is negative and so ξ is negative too.

In the FRC and FRP case, i.e. when $\alpha^G \neq 0$, the dynamics of the model can be summarized by equations 3.22, 3.23 and 3.24. Assuming no shocks ($\rho'_{t+1} = \eta^{G'}_{t+1} = 0$), these equations can be written in state space form in the following way:

$$\begin{bmatrix} z^1_{t+1} \\ \eta'_{t+1} \\ z_{t+1} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -I\mu & \phi & J \\ -(1+\mu)I & \phi & J+H \end{bmatrix} \begin{bmatrix} z^1_t \\ \eta'_t \\ z_t \end{bmatrix}$$

where $I = \frac{PY}{QK}\alpha^G$; $J = \frac{\mu(1-\lambda_k)}{\lambda_k} + \frac{\mu I}{1+i^G}$ and $H = \frac{1}{\lambda_k} + \frac{I}{1+i^G}$.[31]

The characteristic equation of the matrix of coefficients is the following:

$$P(\varphi) \equiv \varphi^3 + (-J - H - \phi)\varphi^2 + (H\phi + (1+\mu)I)\varphi - \phi I = 0 \tag{3.7.78}$$

In order to see determinacy we have to check the conditions that we described on Appendix 3.7.1.

Under a countercyclical fiscal policy (FRC, $\alpha^G > 0$) it is easy to see that $P(-1) < 0$, so equation 3.7.56 is not satisfied and we can discard cases I and III.

In order to have cases II or IV, equation 3.7.58 has to hold. This implies:

$$(1 + \mu - \phi)\frac{Ii^G}{1+i^G} + [\phi - (1+\mu)]\frac{1-\lambda_k}{\lambda_k} < 0 \tag{3.7.79}$$

With a neutral fiscal policy ($\alpha^G = 0$), this condition collapses to $\phi < 1 + \mu$, the same condition that we see at the beginning of this appendix. Assuming $\phi < 1 + \mu$, and with $\alpha^G > 0$ in order to fulfill condition 3.7.79 we need i^G and/or α^G not too big. Intuitively if we have an extreme counter cyclical fiscal policy (α^G too big), then we need i^G small, otherwise after an adverse shock we will increase too much debt and if the interest rate that have to pay public debt is high we can derive in an unsustainable public debt dynamics. In a sense fiscal policy can be so counter cyclical as public debt interest rate allows.

[30] This problem problem is formally identically to the one analyzed by Céspedes, Chang, and Velasco (2004).

[31] If $\alpha_G = 0$ we can show that the previous system collapses to the system presented at the beginning of this section.

If 3.7.79 is satisfied we need an additional condition (3.7.57 or 3.7.60) to have a determinate equilibrium under a counter cyclical fiscal policy. We concentrate here on condition 3.7.60 (case IV of appendix 3.7.1). Under FRC, this condition implies:

$$\alpha^G \phi < \frac{QK}{PY} \tag{3.7.80}$$

Condition 3.7.80 implies that ϕ (persistence of corporate risk) and α^G can not be both too big. Intuitively if we have an aggressive countercyclical fiscal policy, public debt can change too much after a shock which can affect the dynamics of corporate risk (see equation 3.22) and with a very persistent corporate risk process we can derive in an explosive dynamics.

Under a procyclical fiscal policy (FRP, $\alpha^G < 0$) we also have $P(1) < 0$, and so equation 3.7.55 does not hold and we discard cases I and III.

To obtain cases II or IV, equation 3.7.59 has to hold. Under FRP this implies:

$$\alpha^G > \frac{-(1+\phi)\left[1+\frac{1}{\lambda_k}\right] + \mu\frac{1-\lambda_k}{\lambda_k}}{(1+\mu+\phi)(1+\frac{1}{1+i^G})}\frac{QK}{PY} \equiv \alpha^{G^*} \tag{3.7.81}$$

Condition 3.7.81 implies that there is a threshold of how pro-cyclical fiscal policy can be in order to ensure a determinate equilibrium, α^G can not be too negative.

Finally we need an additional condition (3.7.57 or 3.7.60) to have a determinate equilibrium. As in the FRC case we focus on condition 3.7.60 (case IV of appendix 3.7.1).Under FRP, this condition implies:

$$\alpha^G \phi > \frac{QK}{-PY} \tag{3.7.82}$$

As happens under FRC, condition 3.7.82 implies that ϕ (persistence of corporate risk) and α^G (in negative) can not be both too big.

We compute the saddle path: $z_t = \xi_z z_{t-1} + \xi_\eta \eta_t'$. The expressions for ξ_z and ξ_η are given by equations 3.7.83 and 3.7.84, respectively.

$$\xi_z = -\frac{(I\mu - J\varphi_3)(\phi-\varphi_2)\varphi_2 - (\phi-\varphi_3)\varphi_3(I\mu - J\varphi_2)}{(I\mu - J\phi)(\varphi_2-\varphi_3)} \tag{3.7.83}$$

$$\xi_\eta = \frac{(\phi-\varphi_2)(\phi-\varphi_3)}{I\mu - J\phi} \tag{3.7.84}$$

Where φ_3 is the smaller eigenvalue, and φ_2 is the intermediate one.

According to calibration exercises, ξ_z, and ξ_η increases when α^G increases. ξ_z starts from approximately -1 at the most procyclical fiscal policy compatible with determinacy is zero in $FR\overline{B}$ and it is approximately 1 at the most countercyclical fiscal policy compatible with determinacy. ξ_η is always negative but it is a big coefficient (in absolute value) at the most procyclical fiscal policy compatible with determinacy and it is close to zero in a strong countercyclical fiscal policy.

3.7.4 Effects of a financial shock on real depreciation and investment

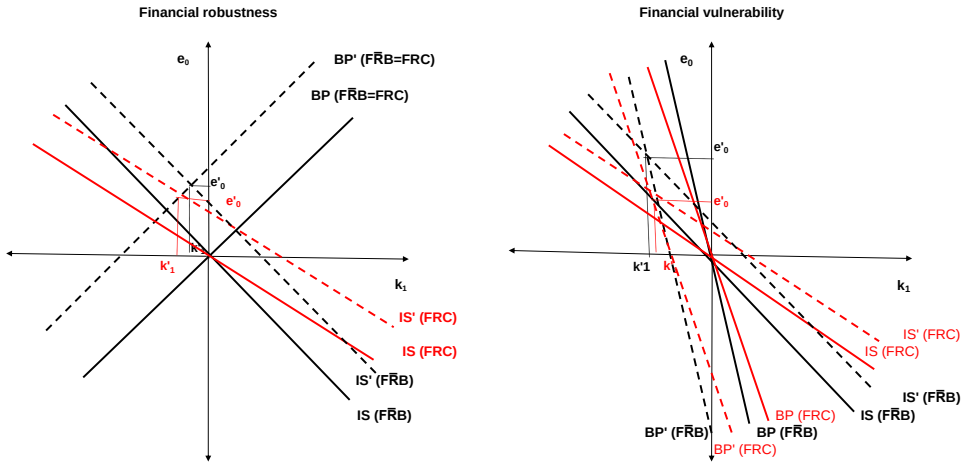


FIGURE 3.8: Financial shock under flexible exchange rate. $FR\overline{B}$ vs FRC case

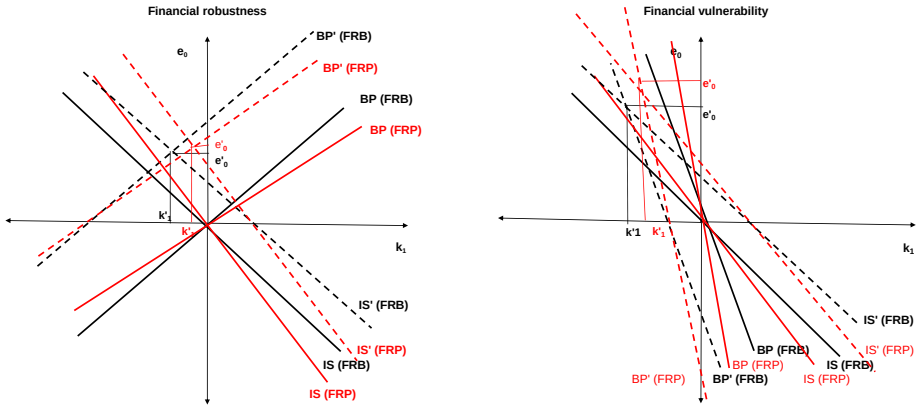


FIGURE 3.9: Financial shock under flexible exchange rate. $FR\overline{B}$ vs FRP case

3.7.5 The dynamics after the shock under flexible exchange rates

In figure 3.10 we show the dynamics of public debt, taxes, output and consumption for 10 periods (the period of the shock and 9 more periods), in the case of flexible exchange rates and under the three fiscal policy regimes considered. The black solid line represents the behavior of the variables under a neutral fiscal policy. For a procyclical fiscal policy (red line with circles) we select $\alpha^G = -0.4$ (if we choose a strong procyclical fiscal policy we have no determinacy). In the countercyclical case (blue dashed line) we select $\alpha^G = 3.5$ in order to see a case where the investment decrease in a vulnerable economy is lower than under $FR\overline{B}$ (for this we need $\alpha^G > 3.2$ with our calibration).

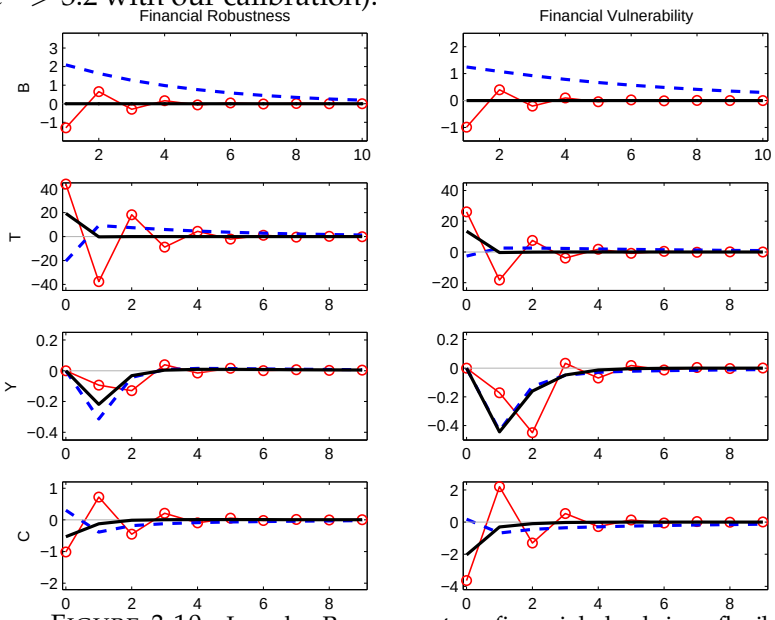


FIGURE 3.10: Impulse Responses to a financial shock in a flexible exchange rate economy under $FR\overline{B}$ (—); FRC (- - -) and FRP (-o-).

In the figure we can see quantitatively the effects that were commented in section 3.4.2.

The period of the shock ($t = 0$) ρ increases unexpectedly 1% and returns to steady state level in $t = 1$ (ρ is 4% previous and after the shock and is 5% the period of the shock).

Under $FR\overline{B}$ (black solid line) public debt in dollars (B) remains constant and fiscal policy increases taxes in the period of the shock in order to ensure this public debt behavior. This implies an increase of taxes of about 20% of its steady state (SS) level in the financial robust economy and an increase a little lower (in % of SS) in the financial vulnerable one. Given that we are working without public expenditure taxes in SS are just what is needed to pay public debt service (see equation 3.19). In our calibration, public debt is 4 times bigger under vulnerability and SS sovereign risk is also bigger in this situation. As a consequence taxes in SS are much higher in a vulnerable situation, and increase more (in absolute value) in order to ensure a constant public debt. This implies that consumption decreases more under vulnerability. The drop in consumption is about 2% from its SS level under vulnerability and about half percent under robustness. Output remains in its steady state level in the period of the shock, ensured by the flexible exchange rate regime. In the period after the shock (t=1) taxes are almost in its steady state level. However consumption experiments a second drop, this time due to the drop in output level. The fall in output is motivated by the investment drop in the

period of the shock and is about 0.5% of its SS level under vulnerability and half of this under robustness. Consumption is 0.3% below SS in this second period under vulnerability and again half of this under robustness. In t=2 output and consumption are almost at SS under robustness but they are again below SS under vulnerability.

If fiscal policy is countercyclical (blue dashed line), public debt is allowed to increase in the period of the shock and so taxes increase less than in $FR\overline{B}$. In the case shown in figure 3.10 ($\alpha^G = 3,5$), taxes directly decreases in t=0. This different movement of fiscal policy prevents consumption from decrease, and with our calibration consumptions increases a little bit. In the next period, output decreases more than with $FR\overline{B}$ under robustness and decreases a slightly less under vulnerability in the example of FRC shown in figure. As we have commented, under robustness FRC implies more investment decrease in the period of the shock and less investment decrease under vulnerability (for α^G large enough). We are using an α^G that is a bit higher than the threshold so we have this effect. Taxes increase in this second period because output in dollars is closer to SS and so public debt has to decrease. Consumption decreases a bit more than in $FR\overline{B}$ in the period after the shock, due to the increase of taxes, amplified by output effect on robustness. After that public debt decreases gradually and the rest of the variables converges to SS. Under FRC there are less depreciation as a response to the shock. This has a beneficial effect for investment under vulnerability (decrease corporate risk and so promotes investment) but has a negative effect under robustness (corporate risk is increased by this effect).

Under FRP (red line with circles) fiscal policy reacts decreasing public debt and increasing taxes more than in the neutral fiscal policy case. As a result, initial consumption decrease is higher under FRP. Investment decreases less with this fiscal policy and the decrease of output in the next period is lower. In t=1 public debt increases and taxes are decreased. Consumption in period 1 is higher under FRP due to the decrease of taxes and also due to the lower decrease of output. This higher level of consumption in t=1 promotes less investment in this period and in t=2 output is lower under FRC. This effect is very important under vulnerability where this drop of output has the same magnitude than the drop in t=1 under $FR\overline{B}$.

3.7.6 The dynamics after the shock under fixed exchange rates

In figure 3.11 we show the dynamics of public debt, taxes, output and consumption the period of the shock and the following 9 periods for $FR\overline{B}$, FRC and FRP under fixed exchange rates. We use the same α^G that we used in the flexible exchange rates case ($\alpha^G = -0.4$ for FRP and $\alpha^G = 3.5$ for FRC).

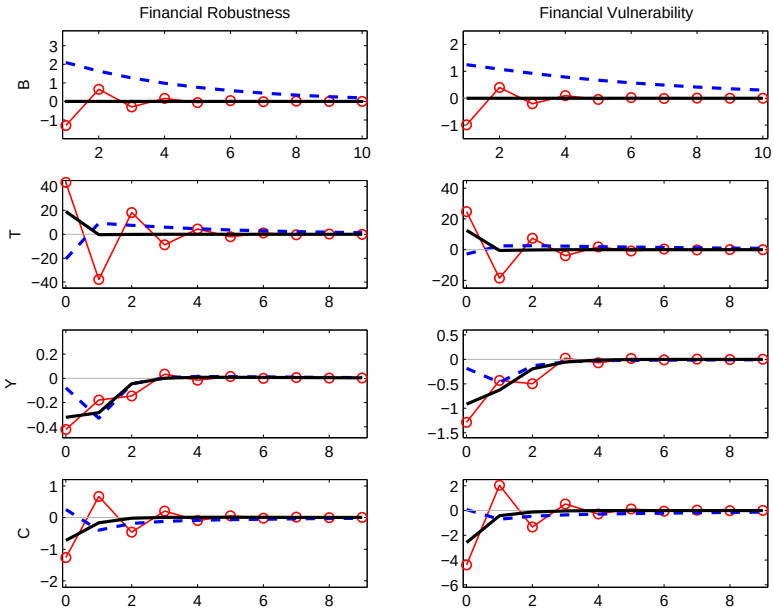


FIGURE 3.11: Impulse Responses to a financial shock in a fixed exchange rate economy under $FR\overline{B}$ (—); FRC (- - -) and FRP (-o-).

Under $FR\overline{B}$, public debt in dollars remains constant and fiscal policy increases taxes as in flexible exchange rates. Taxes increase less than in flexible rates because we have the same increase in ρ, but now real exchange rate increases less. Indeed nominal exchange rate remains constant but P decreases, so even without considering the increase in ρ, taxes are increased in real terms. Output decreases in the period of the shock, about 0.3% in robustness and about 1% in a vulnerable situation. Consumption decreases more than in flexible rates as a consequence of the output drop despite the fact that taxes increase less.

In the period after the shock (t=1) taxes are almost in its steady state level, under $FR\overline{B}$. However consumption experiments a second drop, more intense than under flexible rates, because output is below steady state (investment decreased more under fixed exchange rates). After that output and consumption converges to its steady state (more slowly under vulnerability).

When fiscal policy is countercyclical, public debt increases and taxes increase less than in $FR\overline{B}$, as in flexible rates. Now this behavior has the effect of avoiding the drop in consumption but also (by inducing a lower depreciation) implies a drop in output less intense (-0.2% instead of -1% under vulnerability and -0.1% instead of -0.3% under robustness). In the second period, output decreases a bit more than with $FR\overline{B}$ in robustness and decreases less under the example of FRC shown in figure. Taxes are increased and public debt starts its convergence to its long run equilibrium. Consumption decreases a bit more than in $FR\overline{B}$ in the period after the shock, due to the increase of taxes.

Under FRP public debt decreases and taxes increase more than in $FR\overline{B}$ the period of the shock. The initial drop in consumption is higher under FRP, and the

initial recession is also amplified by this fiscal policy. As in flexible rates, investment decreases less and the fall of output in t=1 is lower. In this second period public debt increases and taxes are decreased. Consumption in the period after the shock is higher under FRP due to the decrease of taxes and also due to the lower decrease of output.

3.7.7 Effects of a financial shock on taxes and labor

		Financial robustness				Financial vulnerability			
α^{ER}	α^{G}	$\sum t/n$	$\sigma^2{}_t$	$\sum l/n$	$\sigma^2{}_l$	$\sum t/n$	$\sigma^2{}_t$	$\sum l/n$	$\sigma^2{}_l$
0	-0,6	1,09	2375,75	-0,07	0,05	0,78	543,08	-0,23	0,55
0	-0,4	1,81	412,69	-0,06	0,04	1,09	112,93	-0,20	0,39
0	0	1,87	36,36	-0,05	0,02	1,18	16,03	-0,14	0,20
0	3,5	1,85	68,53	-0,01	0,00	1,26	2,47	-0,03	0,01
0	8	0,84	85,38	-0,01	0,00	0,72	2,98	-0,01	0,00
0,5	-0,6	1,11	2378,98	-0,05	0,03	0,83	546,20	-0,17	0,30
0,5	-0,4	1,83	414,07	-0,05	0,02	1,13	114,66	-0,15	0,21
0,5	0	1,88	36,76	-0,04	0,01	1,21	16,67	-0,10	0,11
0,5	3,5	1,85	68,39	-0,01	0,00	1,27	2,42	-0,02	0,00
0,5	8	0,84	85,30	0,00	0,00	0,72	2,96	-0,01	0,00
1	-0,6	1,15	2385,10	0,00	0,00	0,97	554,11	0,00	0,00
1	-0,4	1,87	417,37	0,00	0,00	1,25	119,49	0,00	0,00
1	0	1,91	37,86	0,00	0,00	1,30	18,54	0,00	0,00
1	3,5	1,86	68,05	0,00	0,00	1,29	2,30	0,00	0,00
1	8	0,85	85,10	0,00	0,00	0,73	2,89	0,00	0,00

3.7.8 A second order approximation to the utility function

In this appendix we follow a similar procedure as Galí (2008) to obtain a Taylor second-order approximation to the utility (U) of the representative consumer. This approximation around a steady state (C,L) can be expressed as:

$$U_t - U \approx U_C C(\frac{C_{it} - C}{C}) + U_l L(\frac{L_{it} - L}{L}) + \frac{1}{2}U_{cc}C^2(\frac{C_{it} - C}{C})^2 + +\frac{1}{2}U_{ll}L^2(\frac{L_{it} - L}{L})^2 \tag{3.7.85}$$

Using equation 3.5, we can rewrite equation 3.7.85 in log deviations as:

$$U_t - U \approx U_C C\left(c_{it} + \frac{1-\varsigma}{2}c_{it}^2\right) + U_l L\left(l_{it} + \frac{v}{2}l_{it}^2\right) \tag{3.7.86}$$

A second order approximation to the utility of the representative consumer, expressed as a fraction of steady state consumption, can be written as:

$$W = E_0 \sum_{t=0}^{\infty} \beta^t \frac{U_t - U}{U_C C} = E_0 \sum_{t=0}^{\infty} \beta^t \left[\left(c_{it} + \frac{1-\varsigma}{2}c_{it}^2\right) - (1-\alpha)\frac{Y}{C}\left(l_{it} + \frac{v}{2}l_{it}^2\right)\right] \tag{3.7.87}$$

If we take unconditional expectations on equation 3.7.87 and letting $\beta \longrightarrow 1$, the expected welfare losses can be written:

$$L = (1-\alpha)\frac{Y}{C}\left[avg(l_t) + \frac{v}{2}var(l_t)\right] - \left[avg(c_t) + \frac{1-\varsigma}{2}var(c_t)\right] \tag{3.7.88}$$

3.7.9 Endogenous sovereign risk

According to the literature in sovereign risk, this premium depends on the level of debt, the gdp level, and other determinants, see for example: Schmitt-Grohe and Uribe (2003), Adolfson et al. (2008), Badarau, Huart, and Sangaré (2014), Basal et al. (2016), Pienkowski (2017) among others.

For tractability we use the following specification for the sovereign risk premium:

$$(1+\eta^G_{t+1}) = e^{\mu^G\left(\frac{B_{t+1}}{Z_t}-\frac{B}{Z}\right)}(1+\eta^G) \tag{3.7.89}$$

According to 3.7.89, sovereign risk premium is above its steady state level, when public debt over gdp ratio is above its long run equlibrium level. The parameter μ^G determines the sensibility of the risk premium to changes in the public debt to gdp ratio.

Log-linearizing equation 3.7.89 around the steady state we arrive to:

$$\eta^{G'}_{t+1} = \mu^G \frac{B}{Z}(b_{t+1}-z_t) \tag{3.7.90}$$

In period 0, using 3.46 and 3.24 we can express 3.7.90 as:

$$\eta^{G'}_1 = \mu^G \frac{B}{Z}\left(1+\frac{\alpha^G Z}{B}\right)\left(\frac{1-\alpha^{ER}(1-\alpha)}{\alpha}\right)e_0 \equiv \epsilon_{\eta^G e}e_0 \tag{3.7.91}$$

In this environment the IS becomes:

$$e_0 = \frac{-\lambda_k(1+i^G)B\alpha k_1 + \lambda_b B\alpha\rho_1^{'}}{-\left[-1+(1-\alpha)\alpha^{ER}\right]\left[(1+i_G)B+\lambda_B\alpha^G Z\right]-(1+i_G)B\alpha\lambda_k\gamma-\lambda_B B\alpha\epsilon_{\eta^G e}} \tag{3.7.92}$$

The BP curve is:

$$e_0 = \frac{k_1+\left(1+(1-\xi_\eta)\epsilon_{\eta i^G}\right)\rho_1^{'}}{\gamma+(\epsilon_{ye}-1)\left[\xi_z+\epsilon_{\eta e}(1-\xi_\eta)\right]-(1-\xi_\eta)\epsilon_{\eta i^G}\epsilon_{\eta^G e}} \tag{3.7.93}$$

where $\epsilon_{ye} \equiv -(1-\alpha^{ER})\left(\frac{1-\alpha}{\alpha}\right)$

3.7.10 Optimal policy combinations with endogenous sovereign risk $\mu^G = 0.02$ and vulnerability

Rank	α^{ER}	α^G	Welfare losses
1	0.96	-0.6	0.1967
2	0	7.2	0.1977
3	0.04	7.2	0.1978
4	0.08	7.2	0.1978
5	0.12	7.2	0.1978
6	0.16	7.2	0.1978
7	0.2	7.2	0.1979
8	0.24	7.2	0.1979
9	0.28	7.2	0.1979
10	0.32	7.2	0.1980

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