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The Argentine banking and exchange crisis of 2001: can we learn something new about financial crises?

1. INTRODUCTION

After more than ten years under a Currency Board regime that was successful in abating inflation and ensuring macroeconomic and financial stability, in January 2002, Argentina abandoned the "Convertibilidad" and moved to a floating exchange rate regime, in the middle of the probably most deep economic, political and institutional crisis experienced by the country in years.

In terms of its magnitude, broadness and dynamics this crisis seems to be a quite different phenomenon from the Tequila crisis of 1995 or that experienced by Argentina during the 1980's. It is an impressive thing, however, that while abundant ex post analysis has given evidence that Argentina was apparently under an

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unstable path of stagnated output, increasing external indebtness and scarce external financing since early 1999, it was not until mid 2001 that multilateral financing organizations as well external and domestic informed investors recognized that the country was in big trouble, trapped on a vicious circle of stagnation and lack of financing.

An also striking feature of the 2001 Argentine crisis is the apparent strength of the Argentine Financial System at the time the crisis unchained. After the adoption of the "Convertibilidad" in 1991, Argentina implemented a deep financial reform including a financial liberalization, in particular after the Tequila crisis of 1995. At the same time, strong prudential regulations were introduced, putting the Financial System regulations in line to Basle recommendations.

The country benefited from those reforms, being nearly immune to financial contagion during the Asian crisis. There were, however, hidden potential solvency risks at the financial sector, associated to the high dollarization of private sector bank debt and the increasing reliance of the public sector in bank financing. A real depreciation of the currency and /or a loose of access of the government to external financing could undermine the quality of banks assets.

Different explanations have been recently offered about the roots of this event and its particular dynamics. In general all of them agree in viewing the crisis as a very complex phenomenon impossible to be understood as generated by a unique cause. According to Perry and Serven (2002), Argentina began to face a severe problem of overvaluation of the currency since 1998 after being hit by several external shocks. Since then the country authorities faced a hard policy dilemma: to allow for a nominal devaluation in order to let the real exchange rate move towards a new equilibrium level, at the expense of a severe bank insolvency problem due to the high dollarization of banks portfolios, or to keep the currency board intact and let the economy adjust through a painful deflationary process. They emphasize that the roots of this dilemma lie on a structural problem of the Argentine economy: while from the point of view of the real economy, i.e. its trade structure, a peg to the dollar was clearly inconvenient, due to a long story of high inflation, hyperinflation and deposits freezing there was a high preference for the dollar as a store of value.

Hausmann and Velasco (2002) put special emphasis on the growth trap in which the economy was caught due in great extent to the inflexibilities of the Argentine "Convertibilidad" to respond

to large shocks as to which emerging economies are frequently subject. They also stress the role played by banks balance sheet dollarization in amplifying the potential negative effects of a devaluation on economic activity as crucial factor explaining the reluctance of the government to introduce changes in the monetary regime to allow for a relative prices correction to avoid an unsustainable overvaluation of the currency.

In a recent paper, Galeani, Heymann and Tomassi (2002) put emphasis on the crucial and at the same time paradoxical role played by the "Convertiblidad" scheme. On the one hand that it worked as a kind of basic framework facilitating the construction of a system of contracts. This framework made possible an enlargement of consumption and investment opportunities. Due to macroeconomic instability, Argentina lacked for years of any financing for investment and growth. On the other hand, while allowing for an apparent change in the growth trend of Argentina, the impressive results of the "Convertibilidad" regime reinforced the perception that it had driven a permanent rather than a temporary change in real wealth. They argue that under this expectations, contracts were extremely vulnerable to external shocks that could lower future real income paths, since they were built contingent on excessively optimistic perceptions of the future performance of the economy. The fact that an increasing number of dollar denominated contracts were written over time increased the exit costs of the currency board. According to their view, this could explain why the successive economic authorities under different administrations decided to "double their bet" in the "Convertibilidad" scheme.

The strategy we adopt here to study the nature of the banking crisis of 2001 is to analyze the behavior of daily changes in individual bank's deposits. Our idea is that this dynamics can provide rich information about the way in which economic agents' expectations reacted to incoming relevant information about the state of the economy and as well as policy and market responses to these news. Thus, we believe that by assessing this dynamics we would be able to disentangle the relevant factors driving the banking and currency crisis: To what extent the run was caused by the perception of depositors of an increasing aggregate risk rather than a run on a particular kind of banks, probably more exposed to currency risk than others because of the composition of their balance sheets or because of their ownership (being foreign banks probably perceived less vulnerable than domestic). We also want to determine if those banks that were large lenders of

the Argentine government were subject to a more intense withdrawal than others.

The paper is organized as follows: In section 2 we review the literature on banking crisis and in section 3 we briefly describe the main features of the banking crisis during the different subperiods we have identified. In section 4 we describe the model to be estimated and present the econometric results. Section 5 concludes.

2. BANK PANICS IN THE LITERATURE

A considerable amount of theoretical and empirical research has been devoted to explain the phenomenon of bank panics.[1] Most of the theoretical developments on this field ground on the seminal paper of Diamond and Dybvig (1983) and Bryant. These authors model banking crises as random self-fulfilling processes in which individual liquidity needs are fed by a kind of misperception of economic agents about other agents' needs, which can eventually lead to a bad equilibrium in which everybody run on banks.

An alternative theoretical for bank panics is that they unchain because of an increase on aggregate risk. Models in this vein were developed by Wallace (1988, 1990), Jacklin and Bhattacharya (1988), Chari and Jagannathan (1988) and Hellwig (1994). Recently, Chang and Velasco (2000, 2001) and Kawamura (2002) have extended this argument to an small open economy facing "financial illiquidity" as a possible explanation for recent international crisis as those of Asia in 1997 or Brazil in 1999.

A paper developed by Allen and Gale (1998) is particularly appealing for the Argentine ongoing crisis. In their model bank runs are the natural response of economic agents to an increase on aggregate risk due to a reduction on firms' asset value because of, for example, a downturn in economic activity. In this sense, the anticipation by a leading indicator of an imminent recession induces to a deposit withdrawal as a response to an expected fall in firms' asset prices, deteriorating bank's portfolios. Thus, bank panics are caused by a solvency rather than a liquidity problem. A strong result is that bank runs can be optimal in the sense that they produce a first best risk sharing allocation. Thus, their paper

[1] For a detailed and good discussion on the main developments in this field see Freixas and Rochet (1998) Chapter 7.

suggests that for some type of bank runs no government intervention could be the best policy.

Ennis (2002) has recently showed that bank runs induced by self-fulfilling expectations can also be positively correlated with poor fundamentals in a model with multiple equilibriums. He shows two ways trough which the choice of one equilibrium occurs: a selection mechanism in which the best equilibrium is selected, and a learning process. Contrary to the Allen and Gale (1998) model, in which bank runs are an optimal outcome, in a multiple- equilibriums context there is a room for policies preventing the occurrence of a run.

Another possible source of a banking crises is that of contagion. New interest on this phenomenon as a mechanism through which shocks to a particular country or, say bank, can spread internationally or to the whole banking system in different ways, have raised because of the recent financial crisis on emerging markets. This was the case of the Mexican crisis of 1995 or the Asian crises of 1997. There is a sun spot explanation of "contagion" in which there are some equilibriums that lead to a widespread effect of an idiosyncratic shock. On the other hand, contagion could be explained by any positive correlation among real shocks in different countries or banks.

While a wide number of empirical analysis have been developed on contagion, little effort seems to have been devoted to provide a theoretical explanation for the "contagion phenomenon". A recent paper by Allen and Gale (2000) develops a model in which contagion appears due to real links between banks or, in their case, regions. Those links can transform small shocks in one region into a widespread crisis.

A large number of empirical papers test the presence of contagion in recent emerging markets crises. For the Argentinean case, Schumacher (1996) uses a binary choice model to study the Tequila crisis and finds that while contagion effects were not substantial**,** there was evidence of the presence of market discipline during that crisis. On the other hand, D'Amato et al. (1998) study the Tequila banking crisis of 1995, looking at the dynamics of individual bank deposits during that episode testing for alternative hypotheses and find evidence of contagion among bank groups.

Our guess here is that rather than being a sun spot phenomenon, or a bank panic spread to the financial system through contagion effects, this banking and currency crisis is of the second type, i.e. one related to a deterioration of the macro fundamentals. We test the validity of this hypothesis using econometric

analysis to study the behavior of individual bank deposits. We ask several questions that could help to understand what drove the crisis: (i) Was the dynamics of deposits explained by movements on macroeconomic fundamentals? (ii) Were individual banks' fundamentals important in explaining the behavior of deposits, i.e., did market discipline work, in the sense that differences in individual banks' strength explain differences in deposit dynamics? (iii) Was there any evidence of a flight to quality from banks perceived as more weak or risky to those perceived as more solvent or healthy or probably more safe because of being foreign owned or to big to fail? (iv) Was there any evidence of contagion effect among bank groups?

3. THE ARGENTINE 2001 CRISIS. A NEW PHENOMENON OR RATHER MORE OF THE SAME?

In January 2002, Argentina abandoned the "Convertibilidad" and moved to a floating exchange rate regime in the middle of probably the most deep economic, political and institutional crisis experienced by the country in years. The abandoning of the Currency Board was just the last step of an agonic process in which the economy, being immersed in a deep and prolonged recession since the second half of 1998, gradually lost access to international financial markets and suffered during 2001 a banking crisis that the government unsuccessfully tried to repress by putting restrictions on deposit withdrawals until it finally declared default on its debt.

Is this twin crisis different from the Tequila crisis, or those suffered by Asian countries in 1997, or the ones experienced by Argentina and other Latin American countries during the 1980's? As pointed by Chang and Velasco (1998), the 1997 crisis in Asian countries, rather than being a new phenomenon, shared common characteristics with, for example, the Chilean crisis of 1982 and the Mexican crisis of 1994: market–oriented economic reforms, trade and financial liberalization, deregulation and privatization of public enterprises. They also point out that financial fragility, due to inadequate bank regulation and supervision was a main common weakness shared by almost all these experiences.[2]

As pointed above, the Argentine Financial System was appar-

[2] See Diaz Alejandro. (1985), for an illuminating and detailed description of the Chilean and Uruguayan cases.

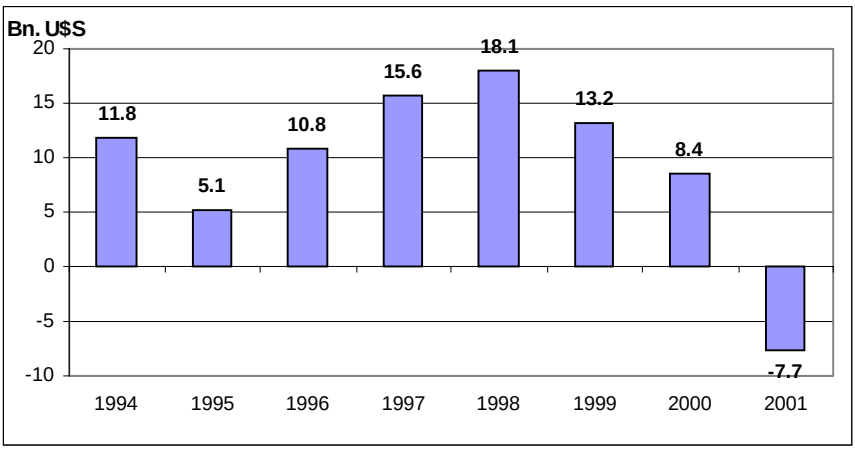
ently strong due to a deep financial reforms implemented in the 90s'. However, the 2001 crisis revealed that two potential risks for the financial sector and the whole economy were underestimated during the good times of the "Convertiblidad". First, financing to the private sector, which was mainly in dollars, was funding private sector domestic borrowers, mainly involved in non-tradable activities. A real exchange rate misalignment, corrected either by a deflation or a nominal devaluation could severely hurt the solvency of no-tradable sector borrowers, making them unable to repay their bank debts.

The second source of financial fragility was the lack of adequate regulation on government debt holdings by banks, either in the form of loans or bonds. Under a currency board regime that put restrictions on government financing, an adequate regulation controlling for this risk on banks' portfolios was particularly relevant.

Successive shocks to international financial markets, the Asian crises of 1997 and Russia in 1998 increased international investors' risk aversion and led to a reversal in capital flows to emerging markets. A recession unchained in Argentina in the third quarter of 1998 and deepened after the Brazilian devaluation of January 1999.[3] After two years of economic downturn, real appreciation of the peso and persistent deterioration on fiscal revenues, doubts emerged about the Government's capability of honoring its debt. The perceived devaluation risk also increased, as the economy proved to be unable to adjust to different financial and real shocks. It also became clear that the combination of a Currency Board regime and highly dollarized banks' balance sheets implied a solvency risk for the financial system in a devaluation scenario, that began to be perceived as more probable. This risk was underestimated during the "good times" in which the economy grew steadily, fueled by capital inflows, favorable terms of trade and a currency relatively devalued vis a vis that of Brazil (Argentina's main trade partner in the region) (Figures 1 and 2). This was one of the main reasons why the Tequila crisis did not develop as a twin crisis. All participants, foreign and domestic investors, the government, the Central Bank and even Multilateral Financial Institutions assigned a nearly zero probability to the event of a devaluation. Moreover, the success of the econ-

[3] Calvo, Izquierdo and Talvi (2002) present empirical evidence of the strong reversal on capital flows to Latin American countries between 1998 and 2001. During this period this flow declined 4% as a percentage of GDP.

FIGURE 1. CAPITAL INFLOWS

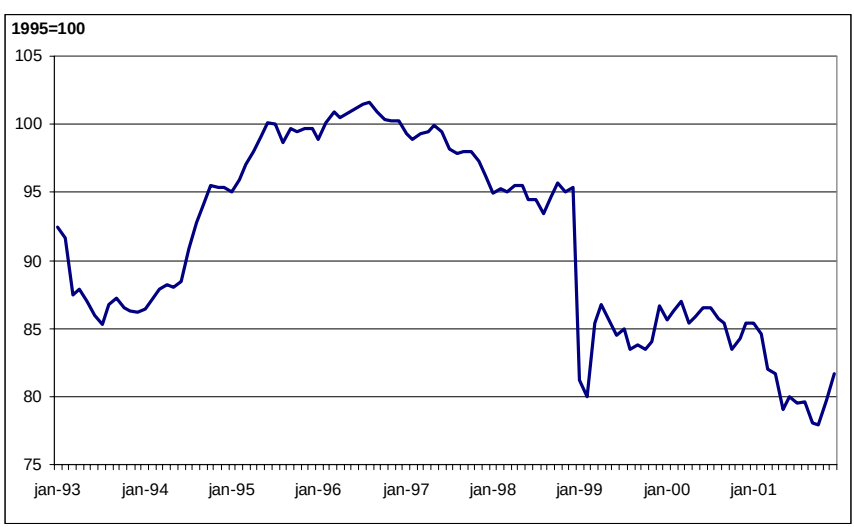


SOURCE: Balance of Payments. MEOySP.

omy on rapidly surpassing the Tequila episode converted the Argentinean "Convertibilidad" into a kind of paradigmatic case frequently invoked as an example to be followed.

Several shocks slowly began to undermine the generalized "op-

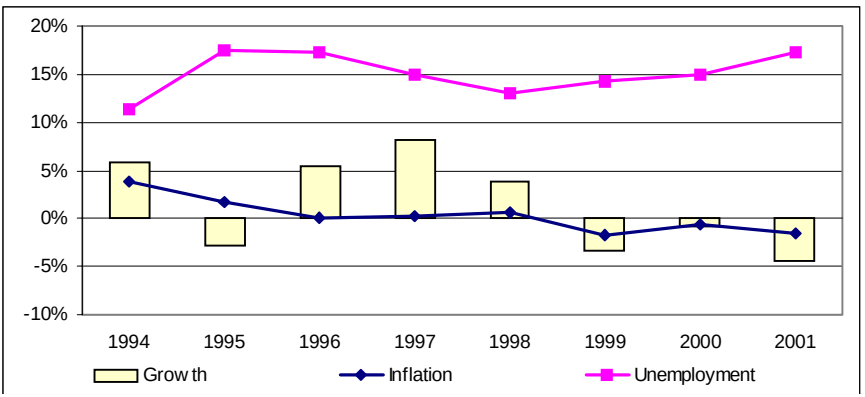
FIGURE 2. MULTILATERAL REAL EXCHANGE RATE (WEIGHTED AVERAGE OF BILATERAL REAL EXCHANGE RATES WITH ARGENTINA'S MAIN TRADE PARTNERS)



SOURCE: Research Department. BCRA.

timistic" perception about Argentina's economic trends, which worked for several years coordinating participants in a kind of virtuous circle, which finally revealed to be fragile.

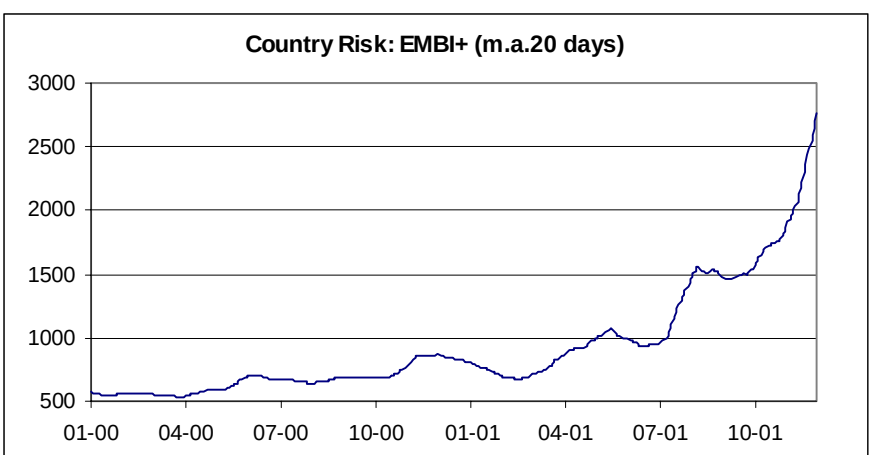
FIGURE 3. ECONOMIC GROWTH, INFLATION AND UNEMPLOYMENT



SOURCE: INDEC

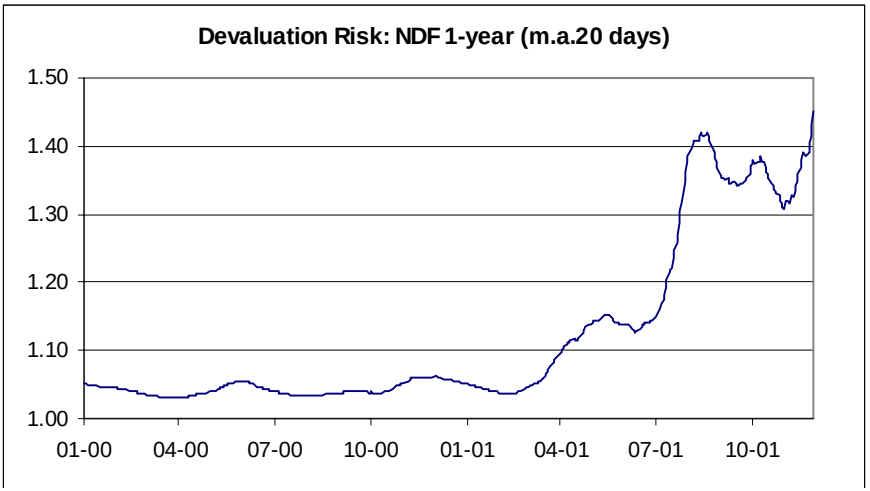
As the economy proved to be unable to adjust to this change in relative prices (Figure 3), in spite of the deflation and the increasing unemployment, the fiscal position deteriorated and confidence of both external and internal investors weakened. A devaluation of the currency and a default on government debt began to be perceived as more probable events, as reflected on currency and country risk indicators (Figure 4 and Figure 5).

FIGURE 4. COUNTRY RISK



SOURCE: JPMorgan.

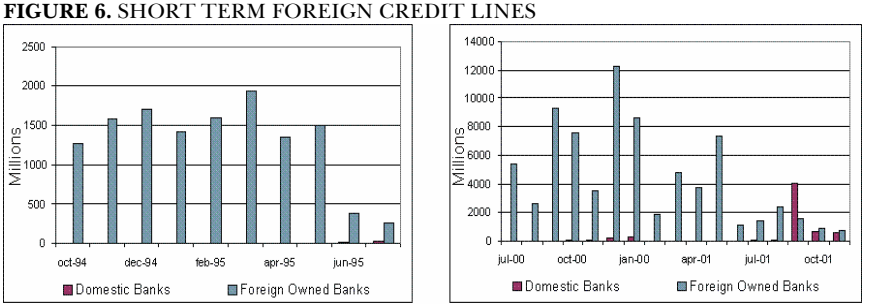
FIGURE 5. DEVALUATION RISK



SOURCE: Bloomberg.

A clear indication of how much higher was the perceived macroeconomic risk in this crisis compared to Tequila is the completely different behavior of banks' short term foreign credit lines compared to this previous episode.[4] Almost all these short term credit lines correspond to financing of head offices of foreign banks. While in Tequila short term foreign credit lines worked as an important source of liquidity, in the ongoing crisis the deepening in deposits fall was accompanied by a decline, rather than an increase in banks' financing through these lines. Figure 6 presents a first picture of how differently these credit lines behaved in both crisis. It is, however, an imperfect approximation, since these figures include not only liquidity assistance, but also foreign

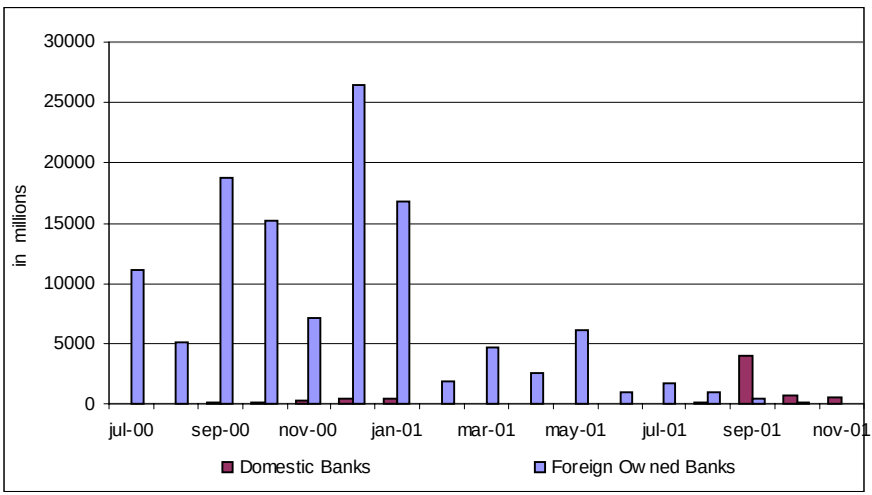
FIGURE 6. SHORT TERM FOREIGN CREDIT LINES



[4] We consider as short term foreign credit lines those with maturity up to fifteen days.

trade financing. In Figure 7 we present figures for 2000-2001[5] excluding this item. They show a sharp contraction in this financing at the beginning of 2001. Thus, it seems that the conventional knowledge assessment that international banks head offices could play the role of an international LOLR of their local offices is not confirmed by the empirical evidence.

FIGURE 7. SHORT TERM FOREIGN CREDIT LINES (EXCLUDING FOREIGN TRADE FINANCING)



SOURCE: BCRA.

Restricted by the "Convertibilidad" in its financing sources, the government tried unsuccessfully to increase tax revenues,[6] a difficult task in the middle of a recession, and began to relay on domestic market financing (i.e. banks, money market funds and pension funds).[7] Although government debt became an increasingly risky asset, this financing was voluntary. In the middle of a prolonged recession that could probably deteriorate the credit quality of domestic private sector borrowers, banks stopped lend-

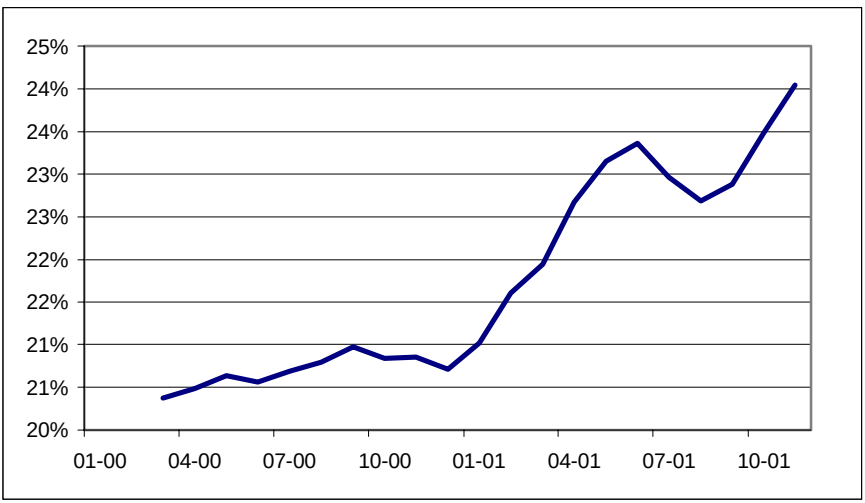
[5] We are not able to compare with 1995, since the data are not disaggregated for this period.

[6] One of the first measures included in the package adopted by the economic team that took office with President de la Rúa in 1999 was to increase income taxes. The new package was supported by the IMF.

[7] It has to be emphasized that in Argentina Pension Funds are mainly related to banks, contrary to what is the most common pension funds scheme, in which insurance companies are the ones involved on this business.

ing to the private sector and increased significantly the weight of government debt (either in the form of bonds or bank lending) in their asset portfolios (Figure 8).[8] This crowding out effect, implied additional financing difficulties for the private sector which contributed to exacerbate the economic downturn (Figure 9).

FIGURE 8. PUBLIC SECTOR DEBT (BONDS AND LOANS) AS % BANKS´ ASSETS (3 month m.a.)

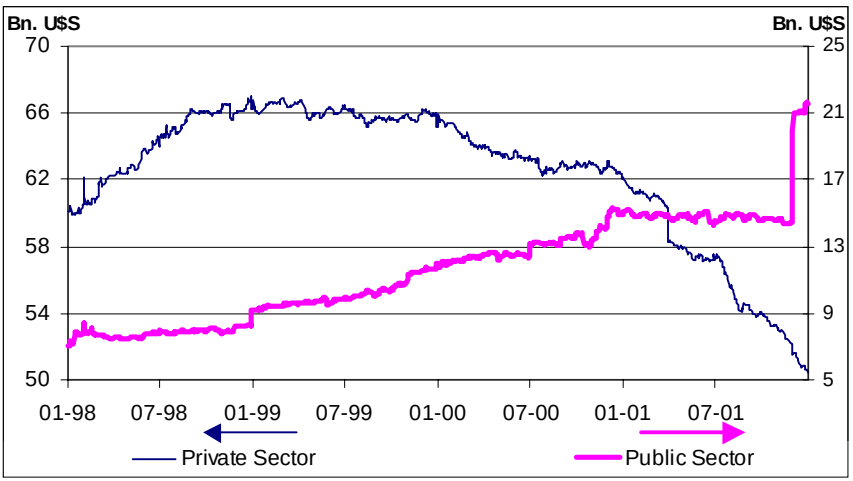


SOURCE: BCRA.

A correction of the real exchange rate misalignment, through either a deflation or a devaluation of the currency implied a solvency problem for the financial system, since 63% of credit to the non-financial domestic private sector (whose income were mostly in pesos) was dollar denominated. The high proportion of government debt in hands of the banks also implied a solvency risk for the financial sector, given the inability of the government to restore confidence and regain access to international markets' financing. Depositors' confidence on the financial sector weakened as they realized that many of the banks would become insolvent in case of a devaluation and or a default on government debt.

[8] It has to be stressed that after the end of 2000, when government financing in international financial markets was severely restricted, this bank financing was in some sense not completely voluntary.

FIGURE 9. BANKS' LOANS TO THE PRIVATE AND PUBLIC SECTOR



SOURCE: BCRA.

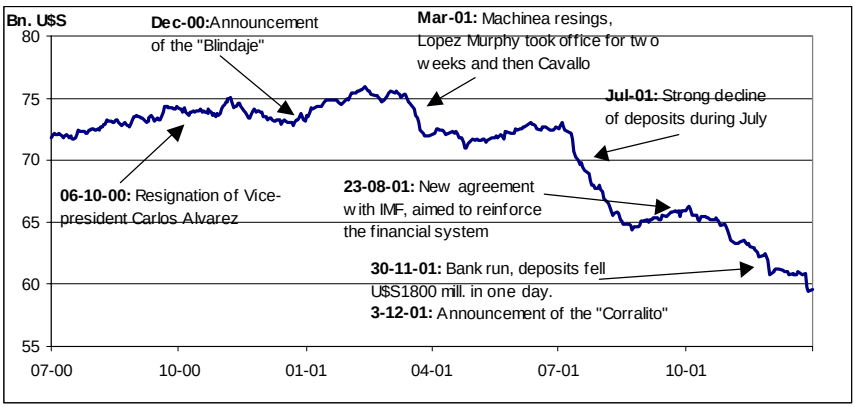
3.1. A chronology of the crisis

By the time the "Convertibilidad" had been abandoned, in January 2002, international reserves at the Central Bank were 42% lower than those of December 2000, and the banking system had lost around 19% of private sector deposits. Contrary to the Tequila episode, an external shock that generated a sudden shift in expectations leading to a sharp but quick fall in deposits and reserves, this crisis evolved through a slowly but persistent erosion of confidence of both domestic and foreign economic agents, as they continued to receive persistent and systematic signals that the economy was unable to recover from the deep recession it entered by the end of 1998.

The crisis developed through several episodes which can be identified by deposits dynamic (Figure 10). They also can be seen through the peso interest rate response to shocks of different nature (Figure 11). We study here the period between July 2000 and November 2001 in which we identify four sub-periods of deposit withdrawals. We consider the November 2000 deposit fall as the initial episode of the crisis, that evolved slowly with ups and downs, until a kind of inconvertibility was declared at the end of November 2001, the so called "Corralito".[9] After its implementation, the

[9] Due to the bank run of the 30th November 2001, the Government imposed strong restrictions on deposit withdrawals. These restrictions were tightened during the crisis and are still at work.

FIGURE 10. TOTAL PRIVATE SECTOR DEPOSITS

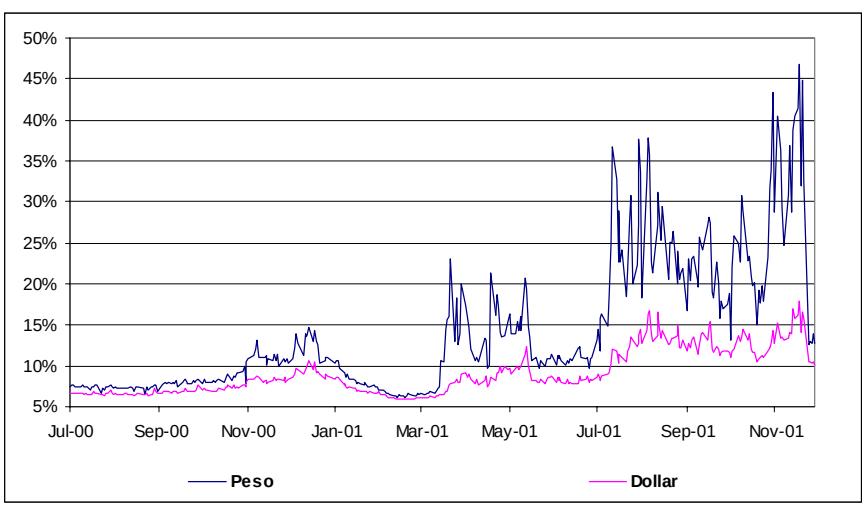


SOURCE: BCRA.

deposit dynamics is noisy, reflecting the effects of withdrawal restrictions, asymmetric pesification and the persistent intend by depositors to avoid them in order to preserve their assets' value. We do not analyze these figures here and restrict our analysis to the above mentioned period.

Figure 10 gives a detailed description of the four episodes. The first one was unchained by a political event, the resignation of vice president Carlos Álvarez in October 2000. This first period

FIGURE 11. PESO – DOLLAR INTEREST RATE (TERM DEPOSITS 30 – 59 DAYS)



SOURCE: BCRA.

goes from the 8th of November 2000 to the 13th of December 2000. The announcement of a rescue package, that assured the funds necessary to cover financial needs during 2001 transitorily alleviated the fiscal situation and stopped deposit withdrawals.

The second episode took place between the 12th of February 2001 and the 30th of March 2001. The failure of the rescue package in restoring confidence reflected on a pronounced widening of sovereign debt spreads. In March 1st the Economy Minister Machinea resigned and Minister Lopez Murphy took office for a short period of time. He announced a fiscal adjustment which was not supported by the "alliance" in power and had to resign. Minister Lopez Murphy was followed by Dr. Cavallo.

After Minister Cavallo took office he implemented several measures aiming to improve the fiscal position of the government, which was particularly critical, given the scarce external market financing and the deepening of the recession, that persistently eroded tax revenues. A tax on financial transactions was introduced, which was very easy to collect and difficult to avoid, in order to increase tax collection. The government also gave signals of the intention of making the "Convertibilidad" scheme more flexible by introducing a fixed peg to a currency basket that included the dollar and the euro. But these announcements were imprecise and generated increasing uncertainty. In addition, several changes were introduced to Central Bank's liquidity policy, which was originally designed with a prudential purpose. The use of liquidity regulations as a tool of monetary policy, weakened confidence on the banking system. On the other hand, in an attempt to recover confidence the government instrumented a debt swap with holders of government debt, known as the "Megacanje".[10] But in July fiscal deficit figures indicated that further reductions on government expenditure were needed given the sharp decline on tax collection and the lack of external financing. The government then announced a zero deficit policy and decided to lower nominal wages of public employees by 13%.

The crisis that unchained in July was much deeper than the previous episodes. Two main features of the macroeconomic situation are probably relevant in explaining the change of attitude of domestic agents. First, the compulsory financing instrumented by the government through the Megacanje made clear to economic agents that the government would be unable to regain

[10] In June a debt swap was implemented that extended the maturity of some bonds in exchange of a higher interest rate.

access to international financial markets and the only source of financing left were the domestic banks system and pension funds. Second, the changes introduced on the systemic liquidity scheme, diverting it from its original purpose, increased fears of a weakening of the financial system. Third, the recognition of an overvaluation of the currency by the economic authorities increased uncertainty about the future course of exchange rate policy, given the ambiguity of the announcements.

By the end of August the economic team negotiated a financial aid from the IMF of U$S 8 billions to support the financial system. In fact, $4 billions went to the Central Bank to reinforce international reserves while, at the same time, the contingent repo program -designed to provide liquidity to the financial system in case of a systemic liquidity crisis- was triggered. These announcement transitorily stopped the deposits withdrawal and even reversed it, until the first days of October in which the release of tax collection figures reveled a significant monthly decline (-14%) and the EMBI spread reached a historical peak of 1850 basic points. The results of the legislative elections of October 14th, which were adverse for the incumbent party also contributed to weaken confidence .This was the beginning of the final episode that ended the 30th of November 2001 with the imposition of the so called "Corralito", a kind of deposits inconvertibility which was tightened afterwards.

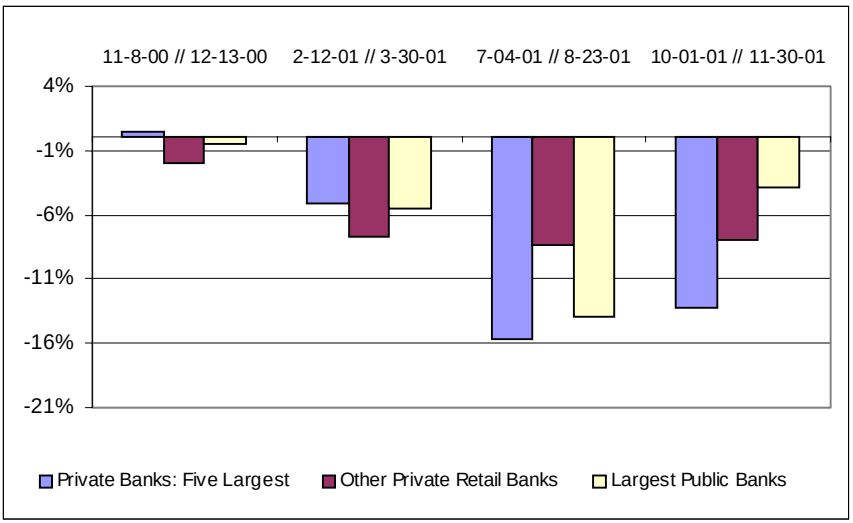
3.2. A first descriptive approach to the dynamics of deposits

As a first approach to the dynamics of deposits we studied the change in deposits by bank groups looking for differences in their performance, which could be an indication of flight to quality or contagion effects. Figures 12 and 13 show how the deposits fall distributed among the main groups of banks operating at the Argentine banking sector.[11]

In the first period private sector deposits at the financial system

[11] We exclude of our sample wholesale banks, both domestically and foreign owned, and non banks, because these groups of financial institutions do not relay on deposits as a main source of financing. Public provincial banks are also excluded from the sample but due to the poor quality of their balance sheet information. We classify retail private banks according to their size in two groups: the five largest vs. the rest. A second classifying criterion is ownership, separating banks in two groups: domestic and foreign owned. The three largest public banks are considered as a separate group.

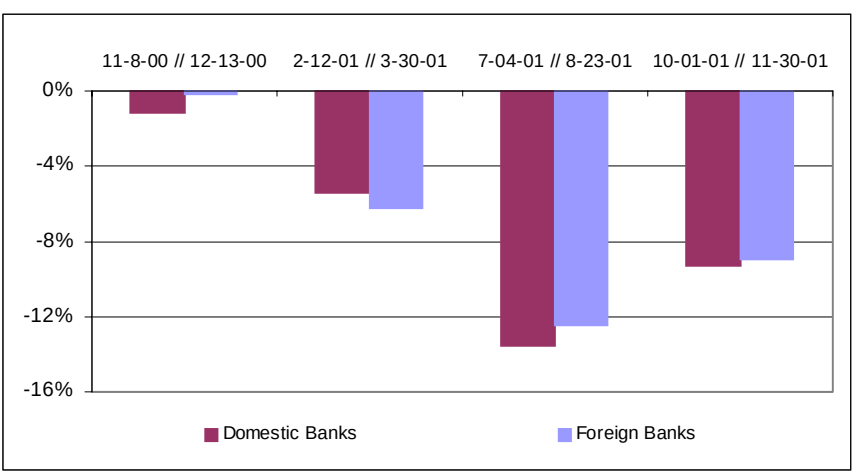
FIGURE 12. CHANGE IN PRIVATE SECTOR DEPOSIT FALL BY BANK GROUPS (ACCORDING TO SIZE)



SOURCE: BCRA.

fell 0.67%. If we compare between foreign and domestically owned financial institutions it can be seen that domestic banks lost more deposits than foreign. The smallest private banks were the ones that lost the most. Thus, the dynamics of deposits during

FIGURE 13. CHANGE IN PRIVATE SECTOR DEPOSIT FALL BY BANK GROUPS (ACCORDING TO OWNERSHIP)



SOURCE: BCRA.

this first period give some indication of a kind of "flight to quality" effect.

The fall in deposits during the second episode was more intense than in the first period (-5.82%) but was rather similar according to the behavior of groups classified by size. The smallest private retail banks were the group that lost the most, followed by the large public banks and the five largest retail banks. If the criterion is ownership, although foreign owned banks lost more than domestic ones this difference is not statistically significant. Thus, average daily figures by bank group indicate that depositors flew more intensely from the smallest financial institutions, probably perceived as weaker compared to large banks (Tables 1 and 2).

TABLE 1. AVERAGE DAILY CHANGE IN PRIVATE DEPOSITS BY BANK GROUPS (ACCORDING TO SIZE)

	From 11/08/00 to 12/13/00	From 2/12/01 to 3/30/01	From 7/04/01 to 8/23/01	From 10/03/01 to 11/30/01
Private Reatail Banks: Five Largest	0.012%	-0.118%	-0.312%	-0.224%
Other Private Retail Banks	-0.055%	-0.179%	-0.167%	-0.136%
Largest Public Banks	-0.015%	-0.127%	-0.279%	-0.067%
All Banks	-0.018%	-0.135%	-0.260%	-0.155%

TABLE 2. AVERAGE DAILY CHANGE IN PRIVATE DEPOSITS BY BANK GROUPS (ACCORDING TO OWNERSHIP)

	From 11/08/00 to 12/13/00	From 2/12/01 to 3/30/01	From 7/04/01 to 8/23/01	From 10/03/01 to 11/30/01
Domestic Banks	-0.032%	-0.126%	-0.271%	-0.158%
Foreign Banks	-0.005%	-0.144%	-0.250%	-0.152%

In the third period 13.02% of total private sector deposits flew from banks, the most intense withdrawal of the whole period. But in this case the largest banks of the system were the ones that suffered the most significant decline. Deposits at the five largest banks fell by 16% while private sector deposits at the largest public banks declined 14%. The smallest private banks suffered less

withdrawals (8.3%). Although foreign banks suffered less deposits withdrawals, the difference with respect to domestic banks is small. Figures by bank groups show that the dynamics of deposits during this episode was completely different form the two previous: The flight of depositors was more intense and depositors flew from large financial institutions.

Finally, in this last period, in which total private sector deposits fall 9.15%, the five largest banks experienced again the deepest fall (13.3%). Deposit at the rest of the private banks fell 8%, while the largest public banks lost only 3.9%.

Summing up, the descriptive analysis by bank group indicates that differences in ownership were not relevant in explaining depositors attitude towards banks, while size mattered. It appears that during the first two episodes the smallest financial institutions suffered a deeper fall, probably because of being perceived weaker than larger banks. The depositors behavior reversed in the two last episodes, where depositors flew more intensely from the largest banks of the system. The increasing exposure of large banks to public sector debt could probably be an explanation of this behavior. In the next section we use econometrics to try to answer some of the questions raised in section 2.

4. EMPIRICAL ANALYSIS

4.1. Estimation methodology

As mentioned in section 2, our perception is that the present crisis in Argentina was due to a change on aggregate macroeconomic risk rather than one based on the perception of weak fundamentals of specific banks. In this sense, the phenomenon we deal with here was unchained by an increase in macroeconomic risk, more specifically by an increasing perception of private agents that a default on government debt was inevitable and that a devaluation of the currency was needed to correct the real appreciation of the Argentine peso, which seemed extremely slow and painful if not impossible under the "Convertibilidad". This event differs from the Tequila crisis, which developed as a systemic crisis in which specific bank fundamentals played a significant role in explaining the dynamics of deposits and there was a flight to quality from small and weak financial institutions to others perceived as stronger.

To determine to what extent this crisis was a bank run based

on aggregate risk rather than one based on a weakening of individual banks which spread through contagion effects, we estimated dynamic panel data models, using two different estimation methods, for daily changes on individual banks' deposits. Additionally, to verify if the contagion hypothesis was relevant for this crisis, we estimated a VAR model where the dependent variables are deposits changes by bank groups (according to size). Using this methodology, we could not find any evidence of significant contagion effects.[12]

The estimation methods used here, take into account the atypical characteristics of our panel, which nearly has the same size in both dimensions, individuals n and time T and both dimensions are "not large, neither small". The literature emphasizes that in this case none of the known estimation techniques gives satisfactory results. The reason for this is that none of the two dimensions is enough large as to ensure that desirable asymptotic properties hold. Thus all methods yield in this case poor estimators.[13] Given the limitations of the available estimation techniques we adopted the strategy of using two different methodologies for estimation propose: the Arellano-Bond method, which is based on a GMM estimator and a GLS estimator.

With respect to the Arellano Bond method, it is a suggested way to deal with the particular characteristics of our model: (i) it contains individual effects (ii) it includes the lagged dependent variable (iii) it contains non strictly exogenous variables. When there are unobservable individual effects the lagged dependent variable (y_{it-1}) is correlated to the error term and that renders the OLS estimator biased and inconsistent even if the error term is not serially correlated. Arellano and Bond suggest first differencing the model to get rid of the individual effects and instrument Δy_{it-1} with y_{it-2} This method leads to consistent but not efficient estimators.[14]

Another appropriate estimation technique for our model is GLS that allows for different residual structure, given the relatively large size of the time dimension of our panel, since the bias problem emphasized by Arellano and Bond diminishes as T increases. This is our second estimation strategy. When using this technique we allowed for the less restrictive residual structure: (i)

[12] The VAR model is available upon request.

[13] See Davidson and MacKinnon (1993), Kievit (1995) and Judson and Owen (1996).

[14] See Arellano and Bond (1991).

heteroscedasticity (ii) correlation across panels and (iii) autocorrelation.[15]

4.2. The empirical model

Our strategy was to proceed in two directions. On the one hand, we estimated a weekly version of the model for the whole period (July 2000-November 2001) that allowed for wide variability in the data by including periods of ups and downs in deposits. It also permitted to include in the model a business cycle indicator, the change in industrial production. On the other hand, we estimated models using daily data for the four bank run episodes described in 3.2 in order to capture the particular features of each episode, given the intuition provided by the descriptive analysis. In both cases models using the two estimation methodologies described in 4.1 were estimated.

The baseline estimated model for the change on individual banks' deposits is the following:

$$\Delta\, dep_{it} = \alpha + \sum_{h=1}^{H} \beta_h \Delta\, dep_{it-h} + \sum_{j=0}^{J} \gamma_j\, r_{it-j} + \sum_{k=1}^{K} \sum_{l=0}^{L} \delta_{kl} X_{iT-l}^{k} + \sum_{m=1}^{M} \sum_{s=0}^{S} \varepsilon_{ms} W_{t-s}^{m} + \sum_{p=1}^{P} \sum_{q=0}^{Q} \lambda_{pq} Z_{t-q}^{p} + u_{it} \quad (1)$$

In the case of the GMM estimation the error term has the following structure

$$u_{it} = \mu_i + e_{it}$$

$$E(e_{it}) = 0$$

$$E(e_{it} e_{is}) = 0 \quad for\ t \neq s$$

In the case of the GLS specification we allow for the following structure of the variance covariance matrix of the error term:

$$E(u_{it}) = 0$$

$$E(u_{it} u_{jt}) \neq 0 \quad for\ i \neq j$$

$$E(u_{it} u_{jt}) = \begin{cases} \sigma_i^2 & \forall\, i = j \\ \sigma_{ij}^2 & \forall\, i \neq j \end{cases}$$

$$u_{it} = \varphi_i u_{it-1} + \upsilon_{it}$$

with e_{it} and υ_{it} being both purely random disturbances.

The variables included in equation (1) are the following:

[15] Panels in this case refer to individuals, in our case, banks.

$\Delta\, dep_{it}$ (Dep Chg), the dependent variable, is the weekly/daily change in individual banks deposits calculated as $log\ dep_t$ - $log\ dep_{t-1}$ as explained by:

i) its own past, given the dynamic characteristics of the model.

ii) The *interest rate on time deposits* r_{it} (Dep Int Rate), which is introduced only in the GMM estimation as a predetermined variable that varies across individuals and time, since there is a strong reason to consider it as endogenous, i. e. banks which are loosing deposits will try to attract funds paying higher interest rates, we introduce it as a predetermined variable.[16] Our hypothesis here is that, among other things, this interest rate gives information about how risky a bank is perceived compared to others, that is, financial institutions that are in a weaker position have to pay higher interest rates on time deposits to attract investors. That is, we assume that

$$E(r_{it}, e_s) \neq 0 \quad for\ all\ s < t\ and\ 0\ otherwhise,$$
$$for\ all\ i, with\ \ i = 1,....N\ and\ all\ \ t, s = 1,...., T,\ in \quad (1)$$

For each bank, the interest rate paid on deposits can be influenced by past changes on deposits, but its contemporaneous value can be considered as independent of current changes.

iii) The X^k variables, are the exogenous individual banks fundamentals, that intend to capture to what extent depositors were able to discriminate between banks depending on their health in terms of their solvency, liquidity, profitability and net wealth. Variables in this group vary across individuals and time, although with a lower frequency (monthly) than the dependent variable, since the data to construct the ratios are basically balance sheet variables. These fundamentals include:

- The *ROE* calculated as 12 month cumulative interest and non interest income, net of operative and financial costs, to equity. (ROE)
- A *leverage* ratio calculated as the ratio of net liabilities to net wealth. (Leverage).
- The ratio of *non performing loans to total loans*, as an indicator of the credit quality of banks loan portfolios. (NPL)

[16] We did not include the interest rate the GLS specification since we didn't find adequate instruments for this variable.

- A ratio *of risky assets to total assets*, where risky and total assets are those considered by the capital requirement regulation for the calculation of capital requirements. (RiskRatio)
- The ratio of *government debt to total assets*. This variable includes banks' public bond holdings as well as lending to the national, provincial and municipal governments. Although it is not a variable traditionally considered as a "fundamental" we include it , given the role played by banks as main financing source of the government. (Pub Debt)
- The ratio of *Liquid Assets to Liquid Liabilities* as a measure of individual banks' liquidity (LiqAss).

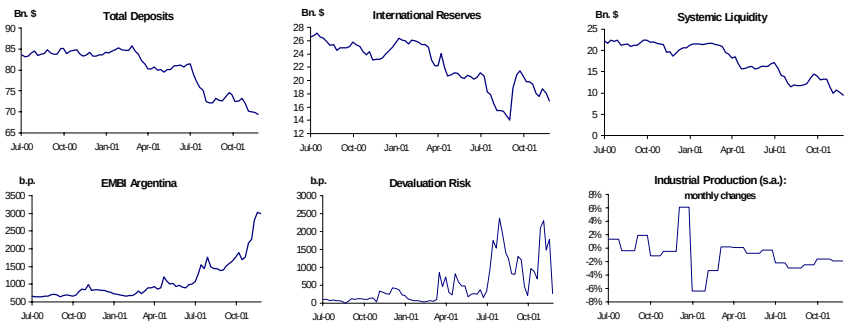
iv) The W^m variables are the "macro fundamentals" that account for changes on aggregate risk. Except for the industrial production index (Ind Prod), which has a monthly frequency, the macro fundamentals are introduced in a weekly/daily frequency and for this reason, can only be included in the model for the whole period. The list of variables included in the set is the following:

- The *change on Central Bank international reserves*. (IntRes Chg)
- The *EMBI spread* as a measure of changes on perceived country risk. (EMBI)
- *Devaluation risk measured* by the spread of the average interest rate on peso denominated deposits and the interest rate on dollar denominated deposits. (Deval Risk) or by the NDF one year.
- *Aggregate liquidity of the Financial System*, given by total liquid assets that banks have to hold to fulfill the liquidity regulations of the BCRA. There were regulatory changes over this period. At the beginning, the BCRA reduced liquidity requirements to provide liquidity to financial institutions. In June 2001, liquidity requirements were replaced by reserve requirements for sight deposits. (SysLiq Chg).

v) The Z^p are control variables. Dummies were used to control for seasonality, group effects and slope changes. The multiplicative dummies controlling for slope were created to capture the dramatic changes of slope for the previously mentioned periods. We also introduced a multiplicative dummy variable, controlling for asymmetries in the behavior of the dependent variable. This dummy variable takes the value of the change in deposits in *t-1* if the change in *t* is positive, and cero otherwise. The sign of this dummy is negative, indicating that when de-

posits increase the autoregressive process is less persistent. This result is interpreted as a signal that depositors are more worried about the past trend in deposits when they are falling than when they are growing. Seasonal daily dummies were also introduced.

FIGURE 14. MACRO FUNDAMENTALS



Descriptive statistics of all variables are presented in Appendix A.

4.3. Results

4.3.1. A model for the complete period with weekly observations

We present here the results of the estimation of a model for the complete period of analysis, July 2000-November 2001. In this case the dependent variable is the weekly change in individual banks' private sector deposits. The model was estimated using the two techniques described above: the Arellano Bond GMM estimator and GLS. Both estimations include all the variables in equation (1), with the exception of the interest rate on deposits by bank in the case of the GLS version. Due to its endogeneity we included it only in the GMM estimation, in which the use of instrumental variables allows to incorporate endogenous variables that can be treated as predetermined.

Given the length of the sample period we were also able to introduce the monthly change in the seasonally adjusted index of industrial production (EMI) as an indicator of the business cycle, since the length of the sample period allowed for significant variability in this variable, which is a monthly index.

Table 3.A. presents the final version of the GMM estimation of

equation (1) for the whole sample period. The models were simplified based not only in the individual significance of the variables but also on the evidence of some multicolinearity due to strong correlation among some of the macro variables (see Appendix B).

None of the individual banks' "micro fundamentals" is significant in this version of the model, not even the interest rate on de-

TABLE 3.A. GMM ESTIMATION FOR THE WHOLE SAMPLE PERIOD WEEKLY OBSERVATIONS[a]

```
Arellano-Bond dynamic panel data                Number of obs      =      1872
Group variable (i): codent                      Number of groups   =        26

                                                Wald chi2(11)      =   5120.39

Time variable (t): time                         min number of obs =        72
                                                max number of obs  =        72
                                                mean number of obs =        72
```

One-step results

Dep Chg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Dep Chg						
LD	-.0780202	.0385161	-2.03	0.043	-.1535103	-.00253
Deval Risk						
LD	-.1803642	.0438044	-4.12	0.000	-.2662193	-.0945092
SysLiq Chg						
LD	.0264291	.0146184	1.81	0.071	-.0022225	.0550808
EMBI						
D1	-.2152685	.093818	-2.29	0.022	-.3991485	-.0313885
Ind Prod						
LD	.1524454	.0470886	3.24	0.001	.0601534	.2447373
L2D	.1041471	.0461447	2.26	0.024	.0137052	.194589
Nov00 Mult	-.6895675	.1171344	-5.89	0.000	-.9191467	-.4599884
Mar01 Mult	-.8234214	.1112992	-7.40	0.000	-1.041564	-.605279
Jul01 Mult	-.7351896	.0779353	-9.43	0.000	-.8879399	-.5824392
Nov01 Mult	-.7829423	.0716865	-10.92	0.000	-.9234453	-.6424394
Asymmetry	-.615038	.0612434	-10.04	0.000	-.735073	-.4950031
_cons	-.0026646	.0007327	-3.64	0.000	-.0041008	-.0012285

Two-step results

```
Sargan test of over-identifying restrictions:
         chi2(142) =    12.92     Prob > chi2 = 1.0000

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
         H0: no autocorrelation   z =  -1.84   Pr > z = 0.0656
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
         H0: no autocorrelation   z =   0.51   Pr > z = 0.6069
```

[a] D1 indicates the contemporaneous value of the variable, LD is the first lag, L2D is the second lag, and so on.

posits by bank, a variable introduced as an indicator of depositors perception about banks' soundness. On the contrary, the "macro fundamentals" are very significant in explaining the dynamics of deposits by bank, even though an autoregressive behavior of the dependent variable remains. Devaluation risk, measured by the spread of peso to dollar interest rate as well as the change in international reserves are very significant and have the correct sing. An even stronger result is that the lagged values of the change in the industrial production index, an indicator of the cyclical position of the economy, is also very significant and has a positive sign.

Dummies controlling for changes in slope are also significant as well as the dummy variable incorporated for asymmetries in deposits behavior.

Arellano and Bond (1991) suggest two test to evaluate the correct specification of the model. The first one tests the lack of second order autocorrelation in the first difference of residuals, which is essential for the GMM estimator to be consistent. The second test, developed by Sargan (1958), evaluates the overidentification of restrictions. Under the null hypothesis the set of instruments is correctly specified. As can be seen from the table, our model passes both tests.

Table 3.B shows the results of the estimation of the GLS version of the model for the whole period. The GLS estimation allows for different correlation structures of residuals. The less restricted structure is one which permits heteroscedasticity among panels, as well as cross-sectional and autoregressive specific correlations. In our case correlation among banks could suggest that, depending on the sign of these correlations, contagion (positive) or "flight to quality" (negative) could be present, respectively. The presence of panel specific autocorrelation is an indication of heterogeneity in dynamics of deposits among banks. To choose the correct specification different model structures were compared conducting LR tests to evaluate them, which are presented in Appendix C. According to the LR tests, the correct specification is an heteroscedastic error structure with cross-sectional correlation as well as individual specific autocorrelation of first order. The results of the GLS estimation do not differ significantly from those obtained using GMM: while individual bank's microfundamentals did not appear to be significant, macro-fundamentals' indicators as devaluation risk, the change in international reserves and the change in industrial production are very significant and enter with the correct sign. Another interesting result is

that for the whole period the five largest banks of the system were subject to a more intense withdrawals that the rest. Although the results confirm those obtained using GMM in terms , significant correlations of residuals among individual banks suggest the presence of interactions in the behavior of deposits among banks. The presence of a specific autoregressive process in residuals also indicates that although there was a significant common autoregressive process captured by the first lag of the dependent variable there was also some heterogeneity in the dynamics of deposits across banks. The GLS estimator is able to capture this heterogeneity.

TABLE 3.B. FGLS ESTIMATION FOR THE WHOLE SAMPLE PERIOD WEEKLY OBSERVATIONS

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic with cross-sectional correlation
Correlation:   panel-specific AR(1)

Estimated covariances      =       351          Number of obs      =      1924
Estimated autocorrelations =        26          Number of groups   =        26
Estimated coefficients     =         8          No. of time periods=        74
                                                Wald chi2(7)       =    254.83
Log likelihood             =  4799.963          Prob > chi2        =    0.0000

------------------------------------------------------------------------------
Dep Chg      |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Dep Chg-1    |  -.1377001   .0257599    -5.35   0.000    -.1881885   -.0872117
Deval Risk   |  -.0700807   .0090445    -7.75   0.000    -.0878075   -.0523538
IntRes Chg   |   .0528672   .0096063     5.50   0.000     .0340392    .0716952
IntRes Chg-1 |   .0353261   .0097564     3.62   0.000     .0162038    .0544484
Ind Prod-1   |   .0470135   .0199345     2.36   0.018     .0079426    .0860844
Private5     |  -.0032386   .0008306    -3.90   0.000    -.0048665   -.0016108
Asymmetry    |  -.1923942   .0322993    -5.96   0.000    -.2556997   -.1290887
       _cons |    .002448   .0007365     3.32   0.001     .0010045    .0038915
------------------------------------------------------------------------------
```

Summing up, our results seem to be quite robust since models estimated using both methodologies support our hypothesis that this crisis, contrary to Tequila, was driven by a perception of increasing macroeconomic fragility rather than caused by the belief of individual banks' weaknesses spread to the whole financial system through contagion effects. The change in industrial production could be thought as a leading indicator of a future downturn in asset prices in the spirit of Allen and Gale (op. cit.).

4.3.2. Modeling bank run episodes

In this section we study the particularities of the four bank run episodes in which the crisis evolved until the "Corralito" was imposed in November 30th. Bank group figures (see Table 1) suggested that depositors behavior was not homogeneous between the different sub –periods. Our aim here is to obtain an insight of the particular characteristics of each episode as the crisis developed.

In this case, we estimated equation (1) using daily data on individual banks' change in deposits for the sub-periods described above. Again, models using both methodologies, GMM and GLS were estimated for each period. The results are presented in Tables 4 to 7 for the different sub-periods.

Table 4.A shows the estimation results for the first episode using

TABLE 4.A. GMM ESTIMATION FOR THE FIRST PERIOD DAILY OBSERVATIONS FROM 11/08/00 TO 12/13/00

```
Arellano-Bond dynamic panel data                Number of obs      =       594
Group variable (i): codent                      Number of groups   =        27

                                                Wald chi2(9)       =   1764.90

Time variable (t): time                         min number of obs  =        22
                                                max number of obs  =        22
                                                mean number of obs =        22

One-step results
------------------------------------------------------------------------------
             |               Robust
Dep Chg      |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Dep Chg      |
          LD |  -.1721986   .0607896    -2.83   0.005     -.291344   -.0530533
         L2D |  -.1860548   .0618775    -3.01   0.003    -.3073324   -.0647772
SysLiq Chg   |
          LD |   .1576683   .0948679     1.66   0.097    -.0282694    .3436061
         L2D |   .1146459    .067591     1.70   0.090    -.0178301    .2471219
         L3D |   .0206278   .0746694     0.28   0.782    -.1257215    .1669771
Leverage     |
         L2D |   -.021479   .0062729    -3.42   0.001    -.0337735   -.0091844
LiqAss       |
         L2D |   .2467056   .0938885     2.63   0.009     .0626876    .4307237
Lassets      |   .0004989   .0002372     2.10   0.035     .0000341    .0009638
Asymmetry    |  -1.082346   .0984368   -11.00   0.000    -1.275279   -.8894139
_cons        |  -.0091876    .003547    -2.59   0.010    -.0161396   -.0022356
------------------------------------------------------------------------------

Two-step results

Sargan test of over-identifying restrictions:
        chi2(44) =    17.52      Prob > chi2 = 0.9999

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
        H0: no autocorrelation   z =  -3.14   Pr > z = 0.0017
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
        H0: no autocorrelation   z =   0.20   Pr > z = 0.8418
```

GMM. The results are mixed here. One of the macro fundamentals, the change in Central Bank International Reserves is significant at the 10% level, while at the same time two micro fundamentals, the leverage ratio and individual banks' liquidity enter the model. On the other hand, banks' size also seems to play a role in explaining the different dynamics of deposits across banks. This result is consistent with the findings obtained in section 3.2, i.e. larger financial institutions seemed to have been less subject to withdrawals during this first bank run episode.

TABLE 4.B. GLS ESTIMATION FOR THE FIRST PERIOD DAILY OBSERVATIONS FROM 11/08/00 TO 12/13/00

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: heteroskedastic with cross-sectional correlation
Correlation: common AR(1) coefficient for all panels (0.0058)

Estimated covariances	= 378	Number of obs	= 702
Estimated autocorrelations	= 1	Number of groups	= 27
Estimated coefficients	= 16	No. of time periods	= 26
		Wald chi2(15)	= 3494.31
Log likelihood	= 2986.044	Prob > chi2	= 0.0000

Dep Chg	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Dep Chg-1	-.0929227	.018645	-4.98	0.000	-.1294662	-.0563792
Deval Risk	-.0270343	.0075114	-3.60	0.000	-.0417563	-.0123123
Deval Risk-2	-.0821682	.0092363	-8.90	0.000	-.100271	-.0640653
IntRes Chg	.0316377	.0048332	6.55	0.000	.0221648	.0411105
IntRes Chg-1	.0821012	.0053629	15.31	0.000	.0715901	.0926123
EMBI	-.2008339	.0224818	-8.93	0.000	-.2448974	-.1567704
EMBI-1	.2106087	.0289952	7.26	0.000	.1537791	.2674383
EMBI_-2	-.0878425	.0208426	-4.21	0.000	-.1286932	-.0469918
ROE-2	.0149471	.0011279	13.25	0.000	.0127364	.0171579
Asymmetry	-.2607685	.0154844	-16.84	0.000	-.2911174	-.2304195
Monday	.0036497	.0001659	22.00	0.000	.0033245	.0039749
Tuesday	.003799	.0001723	22.05	0.000	.0034613	.0041366
Wednesday	.0032045	.0001786	17.94	0.000	.0028544	.0035546
Thursday	.002037	.0001678	12.14	0.000	.0017081	.0023659
Lassets	.0009431	.0001221	7.72	0.000	.0007037	.0011824
_cons	-.0089131	.0022169	-4.02	0.000	-.0132582	-.004568

In Table 4.B. the results for the GLS estimation are presented. The adequate residuals structure, according to the LR test (see Appendix C), permits for heteroscedasticity as well as cross-sectional correlation, but with a common coefficient for the auto-

correlation structure. The results indicate that macro variables were very significant. Devaluation risk was relevant with a larger lag structure compared to the GMM estimation. The change in international reserves, as well as the EMBI spread are also significant and have the expected sign. In this case the ROE was the only significant micro fundamental, indicating that more profitable banks lost less deposits. Again the dummy variables controlling for asymmetries and size, as well as the seasonal daily dummies were significant.

TABLE 5.A. GMM ESTIMATION FOR THE SECOND PERIOD DAILY OBSERVATIONS FROM 02/12/01 TO 03/30/00

```
Arellano-Bond dynamic panel data                Number of obs      =       783
Group variable (i): codent                      Number of groups   =        27

                                                Wald chi2(11)      =    957.95

Time variable (t): time                         min number of obs  =        29
                                                max number of obs  =        29
                                                mean number of obs =        29

One-step results
------------------------------------------------------------------------------
             |               Robust
Dep Chg      |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Dep Chg      |
          LD |  -.1270617   .1383502    -0.92   0.358    -.3982231    .1440997
         L2D |  -.2631939   .0680779    -3.87   0.000    -.3966242   -.1297637
         L3D |  -.1914304   .0836321    -2.29   0.022    -.3553463   -.0275145
         L4D |  -.1451421   .0499567    -2.91   0.004    -.2430554   -.0472288
Deval Risk   |
          LD |  -.0764864   .0602764    -1.27   0.204     -.194626    .0416532
         L2D |  -.0677344   .0349156    -1.94   0.052    -.1361677     .000699
         L3D |   -.047157   .0266813    -1.77   0.077    -.0994513    .0051373
         L4D |  -.1000059   .0807176    -1.24   0.215    -.2582095    .0581976
Leverage     |
         L2D |  -.0135729   .0039488    -3.44   0.001    -.0213123   -.0058335
Pub Debt     |
          LD |  -.1785885   .0835452    -2.14   0.033    -.3423341    -.014843
Asymmetry    |  -1.113525   .2711064    -4.11   0.000    -1.644884    -.582166
_cons        |  -.0004211   .0006893    -0.61   0.541     -.001772    .0009299
------------------------------------------------------------------------------

Two-step results

Sargan test of over-identifying restrictions:
         chi2(56) =    17.00      Prob > chi2 = 1.0000

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
         H0: no autocorrelation   z =  -2.11   Pr > z = 0.0352
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
         H0: no autocorrelation   z =   0.74   Pr > z = 0.4609
```

The results for this first episode, characterized by a much less fall in deposit compared to the following three, indicate that both, macro fundamentals as well as variables giving account of indi-

vidual banks' soundness, played a role in explaining deposits' dynamics in this first deposit run. The finding that larger banks were less subject to deposits withdrawals gives some evidence of a flight to quality in this episode. A possible explanation for deposits behavior during this first episode is that a learning process was taking place in which depositors used past information about the behavior of individual banks in previous periods of financial stress to take decisions to protect their savings.

In second period, February 12th 2001 to March 30th 2001, the fall in deposits was much larger (5.82 %). Table 5.A. shows the results for the GMM estimation. Here, devaluation risk plays a role in explaining deposits behavior and at the same time a micro fundamentals, the leverage ratio as well as individual banks holding of public debt are also significant and have the expected sign.

TABLE 5.B. GLS ESTIMATION FOR THE SECOND PERIOD DAILY OBSERVATIONS FROM 02/12/01 TO 03/30/00

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: heteroskedastic with cross-sectional correlation
Correlation: panel-specific AR(1)

Estimated covariances	= 378	Number of obs	= 918
Estimated autocorrelations	= 27	Number of groups	= 27
Estimated coefficients	= 12	No. of time periods	= 34
		Wald chi2(11)	= 287.42
Log likelihood	= 3099.74	Prob > chi2	= 0.0000

Dep Chg	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Dep Chg-1	-.1260076	.0324522	-3.88	0.000	-.1896127	-.0624026
Deval Risk	-.0363945	.0053475	-6.81	0.000	-.0468753	-.0259136
IntRes Chg	.0636982	.0153088	4.16	0.000	.0336935	.0937028
Pub Debt-2	-.0109904	.0020705	-5.31	0.000	-.0150486	-.0069323
Asymmetry	-.0619954	.0241673	-2.57	0.010	-.1093624	-.0146283
Publics	.0019197	.0004713	4.07	0.000	.0009959	.0028434
Private5	.0008667	.0004257	2.04	0.042	.0000323	.0017011
Monday	.0021423	.0004829	4.44	0.000	.0011958	.0030888
Tuesday	.0048696	.0005014	9.71	0.000	.003887	.0058523
Wednesday	.0057803	.0005059	11.43	0.000	.0047888	.0067718
Thursday	.0030355	.00047	6.46	0.000	.0021143	.0039567
_cons	-.0024462	.0005338	-4.58	0.000	-.0034924	-.0014

The GLS results, presented in Table 5.B, do not differ significantly from those of the GMM estimation: devaluation risk as well as the change in Central Bank international reserves are signifi-

cant, while at the same time the exposure of individual banks to public debt also plays a role in explaining deposits' dynamics during this period. In this case the dummy variables controlling for bank group are also significant, indicating that the five largest banks in the system as well as public banks lost less deposits relative to the smaller private banks. The dummy variable capturing asymmetries in the behavior of deposits, as well as those controlling for daily seasonality were also significant. As shown in Table 5.B. the selected residual structure permits heteroscedasticity as well as correlation across panels and panel-specific autocorrelation. Thus, it seems that although there was a common dynamics in deposits behavior in this period there still remained bank specificities not captured by the explanatory variables.

TABLE 6.A. GMM ESTIMATION FOR THE THIRD PERIOD DAILY OBSERVATIONS FROM 07/04/01 TO 08/23/01

```
Arellano-Bond dynamic panel data                Number of obs      =       891
Group variable (i): codent                      Number of groups   =        27

                                                Wald chi2(5)       =    434.88

Time variable (t): time                         min number of obs  =        33
                                                max number of obs  =        33
                                                mean number of obs =        33

One-step results
------------------------------------------------------------------------------
             |               Robust
Dep Chg      |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Dep Chg      |
          LD |  -.1720967   .0250627    -6.87   0.000    -.2212187   -.1229747
IntRes Chg   |
          D1 |   .1022811   .0265754     3.85   0.000     .0501942    .1543679
Deval Risk   |
          LD |  -.0166371   .0084317    -1.97   0.048    -.0331628   -.0001113
Asymmetry    |  -.7284413   .1233439    -5.91   0.000     -.970191   -.4866916
Publics      |   .0007864   .0003459     2.27   0.023     .0001084    .0014644
_cons        |    -.00121   .0003636    -3.33   0.001    -.0019227   -.0004973
------------------------------------------------------------------------------

Two-step results

Sargan test of over-identifying restrictions:
         chi2(64) =    20.46      Prob > chi2 = 1.0000

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
         H0: no autocorrelation   z =  -1.81   Pr > z = 0.0697
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
         H0: no autocorrelation   z =   0.57   Pr > z = 0.5660
```

In Table 6.A. we present the results of the GMM estimation for the third episode, July 4th 2001 to August 23rd 2001. The largest

fall in deposits, 13%, corresponds to this period. The results indicate that macro fundamentals, in particular devaluation risk and the change in international reserves were very significant while at the same time none of the micro-fundamentals was significant. In this period the model suggest that public banks lost less deposits than the rest. This result is, however, not consistent with the data.

TABLE 6.B. GLS ESTIMATION FOR THE THIRD PERIOD DAILY OBSERVATIONS FROM 07/04/01 TO 08/23/01

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic with cross-sectional correlation
Correlation:   no autocorrelation

Estimated covariances      =       378          Number of obs      =       945
Estimated autocorrelations =         0          Number of groups   =        27
Estimated coefficients     =         8          No. of time periods=        35
                                                 Wald chi2(7)       =    373.07
Log likelihood             =  3201.219          Prob > chi2        =    0.0000

------------------------------------------------------------------------------
Dep Chg      |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Deval Risk-1 |  -.0131557   .0038248    -3.44   0.001    -.0206522   -.0056591
IntRes Chg   |   .0683375     .02126     3.21   0.001     .0266687    .1100063
SysLiq Chg   |   .0380495   .0137446     2.77   0.006     .0111106    .0649883
ActLiq-2     |   .0101343   .0014585     6.95   0.000     .0072758    .0129928
Pub Debt-3   |  -.0056331   .0015434    -3.65   0.000     -.008658   -.0026082
Asymmetry    |  -.2934563   .0201681   -14.55   0.000     -.332985   -.2539276
Private5     |  -.0007729   .0004017    -1.92   0.054    -.0015601    .0000144
       _cons |  -.0034217    .000855    -4.00   0.000    -.0050974    -.001746
------------------------------------------------------------------------------
```

Table 6.B. shows the results for the GLS estimation. The selected model allows for heteroscedastiticty and cross-sectional correlation, but none specific nor common autocorrelation in residuals was present. Even more, the lagged dependent variable was not significant. Almost all of our macro fundamentals: devaluation risk, the change in international reserves at the Central Bank and systemic liquidity are very significant, as well as individual banks' exposure to public debt. In this episode the largest banks of the system were subject to a more intense run that the rest. In this case, the results are consistent with the descriptive analysis in section 3.2. These results are quite strong, since they indicate that our explanatory variables adequately capture the dynamics of deposits in this period, and that this dynamics was mainly common.

In this case both methodologies yield quite similar results, indi-

cating that the behavior of depositor in this period was mainly governed by their perception about macroeconomic risk. However, according to the GLS estimation, it seems that banks more exposed to public debt were perceived as riskier. A striking result for this period is that when controlling for bank group, the GLS estimation results are consistent with the data, while they are not in the case of GMM.

TABLE 7.A. GMM ESTIMATION FOR THE FOURTH PERIOD DAILY OBSERVATIONS FROM 10/03/01 TO 11/30/01

```
Arellano-Bond dynamic panel data                Number of obs      =      1014
Group variable (i): codent                      Number of groups   =        26

                                                Wald chi2(9)       =    431.58

Time variable (t): time                         min number of obs  =        39
                                                max number of obs  =        39
                                                mean number of obs =        39

One-step results
------------------------------------------------------------------------------
             |               Robust
Dep Chg      |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Dep Chg      |
          LD |  -.0792448   .0323434    -2.45   0.014    -.1426368   -.0158529
         L2D |  -.1068439   .0596103    -1.79   0.073     -.223678    .0099902
         L3D |  -.0440039   .0186117    -2.36   0.018    -.0804823   -.0075256
Deval Risk   |
          LD |  -.0229113   .0136033    -1.68   0.092    -.0495733    .0037507
SysLiq Chg   |
          D1 |   .0453757   .0224631     2.02   0.043     .0013488    .0894025
EMBI         |
          LD |   -.106604   .0544056    -1.96   0.050     -.213237     .000029
Pub Debt     |
         L2D |  -.2622922   .1511136    -1.74   0.083    -.5584695    .0338851
Publics      |   .0014744   .0007119     2.07   0.038     .0000791    .0028697
Asymmetry    |  -.8661602   .1287609    -6.73   0.000    -1.118527   -.6137934
_cons        |  -.0009565   .0003667    -2.61   0.009    -.0016752   -.0002378
------------------------------------------------------------------------------

Two-step results

Sargan test of over-identifying restrictions:
        chi2(75) =    13.61      Prob > chi2 = 1.0000

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
        H0: no autocorrelation   z =  -2.00   Pr > z = 0.0458
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
        H0: no autocorrelation   z =   1.23   Pr > z = 0.2182
```

Finally, Tables 7.A. and 7.B. present the results for the last period, October 3rd to November 30th of 2001, the date in which the "Corralito" was imposed. For the GMM estimation (Table 7.A.) the macro fundamentals, as well as banks' exposure to public debt

appears to be relevant to explain deposits dynamics. The dummy variable for public banks was also significant and had a positive sign, indicating that public banks were in this period less subject to withdrawals than the rest.

The results for the GLS estimation (Table 7.B.), are quite similar: The macro fundamentals are very significant and only one of the individual bank micro fundamentals enters the model, the ROE. However, the GLS estimation seems to better capture the differences among bank groups revealed by the descriptive analysis: while public banks were the group that lost the less in this period, the large banks private banks where the ones that lost the most. In this case, the selected residual structure also suggests, as for the third period, that no specific dynamics was present.

TABLE 7.B. GLS ESTIMATION FOR THE FOURTH PERIOD DAILY OBSERVATIONS FROM 10/03/01 TO 11/30/01

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: heteroskedastic with cross-sectional correlation
Correlation: no autocorrelation

Estimated covariances	= 351	Number of obs	= 1118
Estimated autocorrelations	= 0	Number of groups	= 26
Estimated coefficients	= 13	No. of time periods	= 43
		Wald chi2(12)	= 214.26
Log likelihood	= 3623.41	Prob > chi2	= 0.0000

Dep Chg	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Dep Chg-1	-.0964069	.0312331	-3.09	0.002	-.1576227	-.0351912
Deval Risk-1	-.0081804	.0022208	-3.68	0.000	-.0125331	-.0038277
IntRes Chg	.0426392	.0112232	3.80	0.000	.0206421	.0646363
SysLiq Chg	.0281818	.0073863	3.82	0.000	.013705	.0426587
ROE-2	.0034213	.0008966	3.82	0.000	.001664	.0051787
Private5	-.0009362	.000521	-1.80	0.072	-.0019573	.0000849
Publics	.001519	.0003774	4.02	0.000	.0007792	.0022587
Asymmetry	-.0914224	.0385318	-2.37	0.018	-.1669434	-.0159015
Monday	.0010301	.0005348	1.93	0.054	-.0000182	.0020783
Tuesday	-.000323	.0005994	-0.54	0.590	-.0014979	.0008519
Wednesday	.0010579	.0005137	2.06	0.039	.0000512	.0020647
Thursday	-.0014855	.000527	-2.82	0.005	-.0025183	-.0004526
_cons	-.0007573	.0005854	-1.29	0.196	-.0019047	.00039

Common features across the four periods are that macro variables are relevant in all periods and for the whole sample in explaining deposits' dynamics. On the contrary, micro fundamen-

tals do not appear to play a key role. In particular, devaluation risk is persistently significant, across almost all periods and for the whole sample. The interest rate that individual banks paid on deposits, a variable that intended to capture depositors perception about individual banks' risk not captured by the micro fundamentals, was not significant also. Models for all periods using GMM pass the Sargan as well as the autocorrelation test, confirming the absence of over identification problems and second order autocorrelation.

Another interesting result, provided by the GLS estimation is that autocorrelations became common rather than specific and even disappeared as the crisis evolved, that is, the dynamics of deposits became a more systemic phenomenon. On the other hand, the GLS estimation revealed that correlations across banks as well as heteroscedasticity remained in all periods. The exposure of banks to public debt, although not systematically, also played a role in explaining deposits' behavior. Tables summarizing estimation results are presented in Appendix D.

Comparing the results obtained using the two estimation techniques, GMM and GLS, the models obtained using the GLS estimator yielded stronger results, in terms of the individual significance of the explanatory variables. On the other hand, the GLS methodology has advantages over GMM in the particular case of our panel, since it permits us not to impose a particular structure to the residuals, but rather to evaluate which fits better to our data.[17]

5. CONCLUSIONS

We studied the dynamics of individual bank deposits during the twin crisis suffered by Argentina since November 2000. Our aim was to determine to what extent this event had the characteristics of a "sun spot" phenomenon -i.e. a random event not related to the real economy- or it was the consequence of a change in economic agents perception about the trend of the Argentine economy.-i.e. an increase on aggregate risk. We were interested on determining if the highly dollarized banks' loan portfolios, as well as their exposure to public sector induced depositors to massively

[17] Since we have a panel which is large in T, the advantages of the Arellano Bond GMM method, designed for panels which are short in T, loose importance.

run on banks as they perceived that macro fundamentals deteriorated.

The empirical results strongly favor the second hypothesis. Macro fundamentals and in particular devaluation risk and the change in industrial production, as a leading indicator of future banks' solvency problems played an important roll in explaining the behavior of deposits during the crisis. The exposure of individual banks to public also plays a role in explaining this dynamics. On the contrary, banks' micro fundamentals" did not contribute significantly to explain the dynamics of deposits. There is also evidence that deposits' dynamics became a more systemic phenomenon as the crisis evolved. Some heterogeneities across banks that were present at the beginning vanished along with the deterioration on the macro fundamentals.

We think that our findings support the assessment that the regulatory framework built up during the 1990 had non trivial weaknesses. The currency board regime favored the perception that debtors would be permanently protected against devaluation risk, inducing a high dollarization of banks' assets. On the other hand, the combination of a currency board regime and a deposit insurance system that did not discriminate between both, domestic and foreign currency, also favored dollarization of deposits. The need of regulations to control for the implied solvency risk generated by the high dollarization of banks' assets was underestimated. More strict regulations on banks' government debt holdings, preventing for excessive default risk taking by financial institutions, were also necessary given the financing restrictions imposed to the government by the " Convertibilidad".

Although it is perhaps early to intend to build policy lessons from the present experience of Argentina, there are some policy recommendations appear quite straightforward: First, a key element to allow for a deepening of the banking system is to develop attractive financial instruments in the domestic currency. Second, given that financial systems are subject to currency risk, regulations must control for this risk. Possible recommendations for a good regulation design could be, in our opinion: (i) regulations must make depositors aware of the higher risk involved in foreign currency deposits, since the Central Bank does not have policy instruments to act as a LOLR in this case, (ii) restrictions must be introduced on bank lending in foreign currency, discouraging excessive growth of foreign currency financing and ensuring a matching between currency denomination of loans and banks'

borrowers income (iii) the sovereign debt risk of banks' asset portfolios must also be controlled.

Latest experiences of emerging market crises and, more specifically, the present Argentinean crisis, made clear that financial liberalization policies must be accompanied by regulations that widely control for banks' risk, and prevent excessive credit expansion. Emerging market economies, probably because of a lack of domestic savings to sustain growth, are very dependent on capital inflows. In this sense banking systems in emerging markets face particular risks not shared by those of mature economies. As a consequence, the regulatory standards for emerging economies' banking systems need to be revised in light of recent experiences, including this of Argentina and might probably depart in some aspects from those of developed countries.

Appendix A: Descriptive statistics

First Period - Daily Observations from 11/08/00 to 12/13/00

Variable		Mean	Std. Dev.	Min	Max	Observations
Dep Chg	overall	-.0017427	.0167176	-.1276654	.0759721	N = 702
	between		.0040413	-.0179191	.0021179	n = 27
	within		.0162397	-.1315259	.0826022	T = 26
EMBI+	overall	.0853077	.0044561	.08	.099	N = 702
	between		0	.0853077	.0853077	n = 27
	within		.0044561	.08	.099	T = 26
Dev Risk	overall	.0288577	.0072848	.0157	.0441	N = 702
	between		0	.0288577	.0288577	n = 27
	within		.0072848	.0157	.0441	T = 26
IntRes Chg	overall	-.0000442	.0118526	-.031032	.021452	N = 702
	between		6.91e-21	-.0000442	-.0000442	n = 27
	within		.0118526	-.031032	.021452	T = 26
SysLiq Chg	overall	-.0024188	.0196962	-.0482567	.0369401	N = 702
	between		0	-.0024188	-.0024188	n = 27
	within		.0196962	-.0482567	.0369401	T = 26
Dep Int Rate	overall	.0897144	.0164912	.0535315	.1390025	N = 702
	between		.01392	.0649064	.1259509	n = 27
	within		.0092252	.0662489	.1261632	T = 26
NPL	overall	.1158408	.0641291	.0084033	.2545958	N = 702
	between		.0651012	.0096557	.2520667	n = 27
	within		.0050523	.1046449	.1410317	T = 26
Leverage	overall	7.91357	2.752343	2.296103	13.78632	N = 702
	between		2.78325	2.349799	13.69676	n = 27
	within		.3243088	6.11244	9.026185	T = 26
LiqAss	overall	.4238018	.1637607	.1618517	1.100725	N = 702
	between		.16485	.1711296	.9465269	n = 27
	within		.0247232	.3552694	.5779996	T = 26
RiskRatio	overall	.7398063	.3013205	.3163343	2.286757	N = 702
	between		.2735014	.316438	1.818493	n = 27
	within		.1365971	-.3137856	1.208069	T = 26
ROE	overall	-.0004017	.1731344	-.619	.212	N = 702
	between		.1758453	-.5760769	.2023077	n = 27
	within		.0125179	-.0724017	.0315983	T = 26
Pub Debt	overall	.1681897	.0984686	0	.5324194	N = 702
	between		.098667	.0447619	.5172862	n = 27
	within		.0175524	.0522859	.2197025	T = 26
Lassets	overall	14.51566	1.565485	11.49232	16.6988	N = 702
	between		1.593639	11.55197	16.68956	n = 27
	within		.0404054	14.32275	14.648	T = 26

Appendix A: Descriptive statistics

Fourth Period - Daily Observations from 10/03/01 to 11/30/01

Variable		Mean	Std. Dev.	Min	Max	Observations
Dep Chg	overall	-.0020339	.0192086	-.1278135	.1357786	N = 1118
	between		.001359	-.0054056	.0003114	n = 26
	within		.0191623	-.1271458	.1364462	T = 43
EMBI+	overall	.2294884	.0535835	.165	.337	N = 1118
	between		0	.2294884	.2294884	n = 26
	within		.0535835	.165	.337	T = 43
Dev Risk	overall	.1339488	.0792442	.0209	.2896	N = 1118
	between		0	.1339488	.1339488	n = 26
	within		.0792442	.0209	.2896	T = 43
IntRes Chg	overall	-.0077663	.0241976	-.1099429	.0884371	N = 1118
	between		8.85e-19	-.0077663	-.0077663	n = 26
	within		.0241976	-.1099429	.0884371	T = 43
SysLiq	overall	-.012233	.0338569	-.1670444	.0361719	N = 1118
	between		0	-.012233	-.012233	n = 26
	within		.0338569	-.1670444	.0361719	T = 43
Dep Int Rate	overall	.1445965	.0445682	.0058971	.39345	N = 1118
	between		.0273971	.0913558	.216395	n = 26
	within		.0355521	.0355807	.3216515	T = 43
NPL	overall	.117001	.065071	.0210613	.2842818	N = 1118
	between		.0661289	.0223714	.2649128	n = 26
	within		.0050629	.0977128	.1372077	T = 43
Leverage	overall	7.130276	2.659884	1.987443	12.51634	N = 1118
	between		2.699826	2.094587	12.33422	n = 26
	within		.244951	6.398566	7.896829	T = 43
LiqAss	overall	.3406664	.1339355	.139216	.721059	N = 1118
	between		.131471	.1460853	.6678507	n = 26
	within		.036111	.1797419	.4942762	T = 43
RiskRatio	overall	.8117003	.1991608	.4615504	1.30476	N = 1118
	between		.2022858	.4695609	1.301289	n = 26
	within		.0168547	.766249	.859316	T = 43
ROE	overall	.038398	.1522134	-.498	.245	N = 1118
	between		.1548696	-.4959535	.2313256	n = 26
	within		.009283	.0128166	.0628166	T = 43
Pub Debt	overall	.1789159	.1218187	.0115506	.5606958	N = 1118
	between		.1236194	.0117107	.5368292	n = 26
	within		.0115166	.1458176	.2135902	T = 43
Lassets	overall	14.40872	1.476486	11.54434	16.65334	N = 1118
	between		1.504156	11.58068	16.6258	n = 26
	within		.0509541	14.25866	14.55195	T = 43

Appendix A: Descriptive statistics

Third Period - Daily Observations from 07/04/01 to 08/23/01

Variable		Mean	Std. Dev.	Min	Max	Observations
Dep Chg	overall	-.0030097	.0211981	-.1418831	.2761466	N = 945
	between		.0023305	-.0059087	.0059028	n = 27
	within		.0210742	-.141323	.2767068	T = 35
EMBI+	overall	.1479429	.0156342	.108	.176	N = 945
	between		0	.1479429	.1479429	n = 27
	within		.0156342	.108	.176	T = 35
Dev Risk	overall	.13014	.0527865	.0331	.2462	N = 945
	between		0	.13014	.13014	n = 27
	within		.0527865	.0331	.2462	T = 35
IntRes Chg	overall	-.0092627	.0160504	-.0527851	.0317441	N = 945
	between		0	-.0092627	-.0092627	n = 27
	within		.0160504	-.0527851	.0317441	T = 35
SysLiq	overall	-.010507	.025036	-.0730543	.0418793	N = 945
	between		0	-.010507	-.010507	n = 27
	within		.025036	-.0730543	.0418793	T = 35
Dep Int Rate	overall	.1343854	.046594	.0356096	.3394246	N = 945
	between		.0316827	.0766406	.1971803	n = 27
	within		.0346896	.0251516	.2784129	T = 35
NPL	overall	.1086384	.0619701	2.73e-06	.2527004	N = 945
	between		.0630145	.0071577	.2523892	n = 27
	within		.0035324	.09563	.1195929	T = 35
Leverage	overall	7.359952	2.913578	1.002766	14.03401	N = 945
	between		2.958938	1.171146	13.68418	n = 27
	within		.2212772	6.617905	8.241133	T = 35
LiqAss	overall	.3778892	.1394887	.1604649	.828198	N = 945
	between		.1372431	.1959214	.7159774	n = 27
	within		.0360533	.2833877	.4901098	T = 35
RiskRatio	overall	.7476076	.1725278	.4120837	1.294314	N = 945
	between		.1729232	.4187073	1.242117	n = 27
	within		.0306663	.6525697	.8276396	T = 35
ROE	overall	.009509	.1934354	-.641	.231	N = 945
	between		.1959993	-.6355143	.2272	n = 27
	within		.0196258	-.0759767	.1110233	T = 35
Pub Debt	overall	.1813685	.1196044	0	.5713592	N = 945
	between		.1170308	.0324004	.5463446	n = 27
	within		.033201	.0829838	.2642189	T = 35
Lassets	overall	14.35768	1.582355	11.18904	16.62506	N = 945
	between		1.611197	11.19015	16.60156	n = 27
	within		.037272	14.19173	14.49743	T = 35

Appendix A: Descriptive statistics

Second Period - Daily Observations from 02/12/01 to 03/29/00

Variable		Mean	Std. Dev.	Min	Max	Observations	
Dep Chg	overall	-.0016788	.0184057	-.1435201	.133002	N =	918
	between		.0021717	-.0070984	.004215	n =	27
	within		.0182818	-.142646	.1384216	T =	34
EMBI+	overall	.0797059	.0092835	.068	.105	N =	918
	between		0	.0797059	.0797059	n =	27
	within		.0092835	.068	.105	T =	34
Dev Risk	overall	.0248265	.0358322	.002	.1508	N =	918
	between		0	.0248265	.0248265	n =	27
	within		.0358322	.002	.1508	T =	34
IntRes	overall	-.0051909	.0104921	-.0441333	.0144749	N =	918
	between		0	-.0051909	-.0051909	n =	27
	within		.0104921	-.0441333	.0144749	T =	34
SysLiq	overall	-.0045972	.0138227	-.0405928	.0219401	N =	918
	Between		0	-.0045972	-.0045972	n =	27
	within		.0138227	-.0405928	.0219401	T =	34
Dep Int Rate	overall	.0723492	.0182985	.0352953	.1754727	N =	918
	between		.0127986	.0564217	.1175108	n =	27
	within		.0133014	.0207907	.1780825	T =	34
NPL	overall	.1158698	.0637549	.0097216	.2637498	N =	918
	between		.0648197	.0100181	.2599017	n =	27
	within		.0037812	.1075213	.1290448	T =	34
Leverage	overall	7.742927	2.547417	2.376495	13.48041	N =	918
	between		2.573591	2.376945	13.36884	n =	27
	within		.3229803	5.940052	8.858992	T =	34
LiqAss	overall	.4635579	.3013001	.2091441	1.860654	N =	918
	between		.3061338	.2281273	1.817935	n =	27
	within		.0208917	.3914991	.5081657	T =	34
RiskRatio	overall	.7089613	.1787898	.3260259	1.161617	N =	918
	between		.1765292	.344588	1.153872	n =	27
	within		.0438711	.5756264	.7915019	T =	34
Roe	overall	.0065479	.1849755	-.603	.236	N =	918
	between		.1881676	-.6018529	.2348529	n =	27
	within		.0091143	-.0244227	.0565773	T =	34
Pub Debt	overall	.1669333	.1077501	0	.4953106	N =	918
	between		.1084544	0	.4803203	n =	27
	within		.0164621	.1111726	.2014519	T =	34
Lassets	overall	14.52343	1.571357	11.39227	16.76556	N =	918
	between		1.599821	11.43735	16.65583	n =	27
	within		.0429288	14.38765	14.65839	T =	34

Appendix B: Spearman Correlations

First Period - Daily Observations from 11/08/00 to 12/13/00

Observations = 26

	Dep Change	EMBI	Deval Risk	Non Del Fwd	IntRes Change	SysLiq Change
Dep Change	1					
EMBI	-0,251	1				
Deval Risk	-0,132	-0,154	1			
Non Del Fwd	0,034	0.692***	-0,081	1		
IntReq Change	0,049	-0.339*	0,155	-0.380*	1	
SysLiq Change	0,064	-0.428**	0,116	-0.304	0.796***	1

Second Period - Daily Observations from 02/12/01 to 03/30/01

Observations = 34

	Dep Change	EMBI	Deval Risk	Non Del Fwd	IntRes Change	SysLiq Change
Dep Change	1					
EMBI	-0,284	1				
Deval Risk	-0,286	0.840***	1			
Non Del Fwd	-0.362**	0.945***	0.875***	1		
IntRes Change	0,246	-0.498***	-0.390**	-0.439***	1	
SysLiq Change	0,198	-0,244	-0,181	-0.183	0.508***	1

Third Period - Daily Observations from 07/04/01 to 08/22/01

Observations = 35

	Dep Change	EMBI	Deval Risk	Non Del Fwd	IntRes Change	SysLiq Change
Dep Change	1					
EMBI	-0.117	1				
Deval Risk	-0.047	0.522***	1			
Non Del Fwd	0.083	0.587***	0.255	1		
IntRes Change	0.428***	-0.279*	-0.016	-0,047	1	
SysLiq Change	0.583***	-0.211	-0.015	-0,027	0.796***	1

Fourth Period - Daily Observations from 10/03/01 to 11/30/01

Observations = 43

	Dep Change	EMBI	Deval Risk	Non Del Fwd	IntRes Change	SysLiq Change
Dep Change	1					
EMBI	-0.289*	1				
Deval Risk	-0.156	0.378**	1			
Non Del Fwd	-0.226	0.636***	-0.041	1		
IntRes Change	0.257*	-0.342**	0.111	-0,045	1	
SysLiq Change	0.521***	-0.309**	-0.055	-0,066	0.697***	1

Whole Sample Period - Weekly Observations

Observations = 74

	Dep Change	EMBI	Deval Risk	Non Del Fwd	IntRes Change	SysLiq Change
Dep Change	1					
EMBI	-0.228*	1				
Deval Risk	-0.355***	0.843***	1			
Non Del Fwd	-0.217*	0.978***	0.856***	1		
IntRes Change	0.275**	-0.283**	-0.198*	-0.301***	1	
SysLiq Change	0.457***	-0.163	-0.132	-0.151	0.771***	1

*** Indicates statistical significance at 1%, ** at 5% and * at 10%.

Appendix C: Likelihood Ratio Test to evaluate models' error structure using FGLS method

Whole sample period - Weekly Observations

	No autocorrelation	Common AR(1) process	Specific AR(1) process to each bank
No autocorrelation		Chi(1)= 1.30 (0.255)	Chi(26)= 75.89 (0.000)
Common AR(1) process			Chi(25)= 74.59 (0.000)

	Homoscedastic error structure without cross-sectional correlation	Heteroscedastic error structure without cross-sectional correlation	Heteroscedastic error structure with cross-sectional correlation
Homoscedastic error structure without cross-sectional correlation		Chi(25)= 1814.9 (0.000)	Chi(350)= 2374.3 (0.000)
Heteroscedastic error structure without cross-sectional correlation			Chi(325)= 559.65 (0.000)

First period - Daily Observations from 11/08/00 to 12/13/00

	No autocorrelation	Common AR(1) process	Specific AR(1) process to each bank
No autocorrelation		Chi(1)= 50.84 (0.000)	Chi(27)= 8.78 (0.999)
Common AR(1) process			Chi(26)=-42.07*

	Homoscedastic error structure without cross-sectional correlation	Heteroscedastic error structure without cross-sectional correlation	Heteroscedastic error structure with cross-sectional correlation
Homoscedastic error structure without cross-sectional correlation		Chi(26)= 450.66 (0.000)	Chi(377)= 2093.2 (0.000)
Heteroscedastic error structure without cross-sectional correlation			Chi(351)= 1642.5 (0.000)

* Negative values for the LR test indicates that the unrestricted model is misspecified.

Second period - Daily Observations from 02/12/01 to 03/30/01

	No autocorrelation	Common AR(1) process	Specific AR(1) process to each bank
No autocorrelation		Chi(1)= 0.11 (0.741)	Chi(27)= 72.89 (0.000)
Common AR(1) process			Chi(26)= 72.78 (0.000)

	Homoscedastic error structure without cross-sectional correlation	Heteroscedastic error structure without cross-sectional correlation	Heteroscedastic error structure with cross-sectional correlation
Homoscedastic error structure without cross-sectional correlation		Chi(26)= 694.1 (0.000)	Chi(377)= 1342.7 (0.000)
Heteroscedastic error structure without cross-sectional correlation			Chi(325)= 648.6 (0.000)

Third period - Daily Observations from 07/04/01 to 08/22/01

	No autocorrelation	Common AR(1) process	Specific AR(1) process to each bank
No autocorrelation		Chi(1)= -0.11*	Chi(27)= 2.35 (1.000)
Common AR(1) process			Chi(27)= 2.47 (1.000)

	Homoscedastic error structure without cross-sectional correlation	Heteroscedastic error structure without cross-sectional correlation	Heteroscedastic error structure with cross-sectional correlation
Homoscedastic error structure without cross-sectional correlation		Chi(26)= 1109.43 (0.000)	Chi(377)= 1760.3 (0.000)
Heteroscedastic error structure without cross-sectional correlation			Chi(351)= 668.4 (0.000)

Fourth period - Daily Observations from 10/03/01 to 11/30/01

	No autocorrelation	Common AR(1) process	Specific AR(1) process to each bank
No autocorrelation		Chi(1)= -0.04*	Chi(26)= 31.75 (0.201)
Common AR(1) process			Chi(27)= 31.80 (0.164)

	Homoscedastic error structure without cross-sectional correlation	Heteroscedastic error structure without cross-sectional correlation	Heteroscedastic error structure with cross-sectional correlation
Homoscedastic error structure without cross-sectional correlation		Chi(25)= 1048.8 (0.000)	Chi(350)= 1524.9 (0.000)
Heteroscedastic error structure without cross-sectional correlation			Chi(325)= 476.1 (0.000)

Appendix D: Summary Results - GLS Estimation

	Deposits Change	EMBI spread	Devaluation Risk	Change in International Reserves	Systemic Liquidity Change	Industrial Production	ROE	Pub Debt % of Assets	Liquid Assets
First Period 11/08/00 al 12/13/00	lag: 1 neg. & sign.	lags: 0- 2 neg. & sign.	lags: 0 & 2 neg. & sign.	lags: 0-1 pos. & sign.			lag: 2 pos. & sign.		
Second Period 2/12/01 al 3/30/01	lag: 1 neg. & sign.		lag: 0 neg. & sign.	lag: 0 pos. & sign.				lag: 2 neg. & sign.	
Third Period 7/04/01 al 8/23/01			lag: 1 neg. & sign.	lag: 0 pos. & sign.	lag: 0 pos. & sign.			lag: 3 neg. & sign.	lag: 2 pos. & sign.
Fourth Period 10/01/01 al 11/30/01	lag: 1 neg. & sign.		lag: 1 neg. & sign.	lag: 0 pos. & sign.	lag: 0 pos. & sign.		lag: 2 pos. & sign.		
Whole Sample	lag: 1 neg. & sign.		lag: 0 neg. & sign.	lags: 0- 1 pos. & sign.		lag: 1 pos. & sign.			

	Control Variables								
	Constant	Private 5	Public	Log of Assets	Asymmetry	Monday	Tuesday	Wednesday	Thursday
First Period 11/08/00 al 12/13/00	neg. & sig.			pos. & sig.	neg. & sig.	pos. & sig.	pos. & sig.	pos. & sig.	pos. & sig.
Second Period 2/12/01 al 3/30/01	neg. & sig.	pos. & sig.	pos. & sig.		neg. & sig.	pos. & sig.	pos. & sig.	pos. & sig.	pos. & sig.
Third Period 7/04/01 al 8/23/01	neg. & sig.	neg. & sig.			neg. & sig.				
Fourth Period 10/01/01 al 11/30/01	neg. & no sig.	neg. & sig.	pos. & sig.		neg. & sig.	pos. & sig.	neg. & no sig.	pos. & sig.	neg. & sig.
Whole Sample	pos. & sig.	neg. & sig.			neg. & sig.				

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Determinants of the Chilean sovereign spread: is it purely fundamentals?

I. INTRODUCTION

The study of the behavior of the sovereign spread has been a permanent interest of the Chilean economic authorities since the issuance of the first bond in April 1999. This paper in part fulfills that need through the study of the determinants of the sovereign spread through two approaches. The first one involves the use of time series models to capture the main characteristics of the stochastic process behind the behavior of Chile's sovereign spread, by making use of daily data. The second approach involves the study of the determinants of the level of the sovereign spread, based on fundamental variables that, according to theory and previous empirical literature, should influence sovereign spreads behavior. This second approach is more limited than the first,

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due to the rather short history of the sovereign spread, and the monthly frequency of fundamental variables data.

The paper has the following structure: Section II briefly describes the different sovereign debt issuance's by the Chilean government in terms of amounts and general conditions, and compares the evolution of Chile's sovereign spread with other emerging markets with Investment Grade rating and other countries of the Latin-American region. Section III is dedicated to the time series analysis of the spread using daily data, in terms of stationarity, ARCH effects, and the estimation of traditional GARCH models and Asymmetric GARCH models. In section IV we carry on the fundamentals analysis, first identifying the variables that determine the level of the spread and then estimating the corresponding models. Section V presents the conclusions.

II. CHILE'S SOVEREIGN DEBT

The Chilean government undertook its first bond issue in early 1999 as a way to achieve several objectives. At first, sound and solid Chilean macroeconomic fundamentals had set a favorable environment for sovereign approaches to international markets. Indeed, one of the factors making suitable to direct public financing toward sovereign debt issuance was the extremely positive Chilean assessment by international investors. Since 1995, Chile has received A- rating by Standard & Poor's (for long term debt in foreign currency) keeping a stable outlook in each review exercise. All of these factors favored a bias toward external issues, involving both a positive scenario for a first sovereign debt issuance and an attractive means for adequate management of public debt structure.

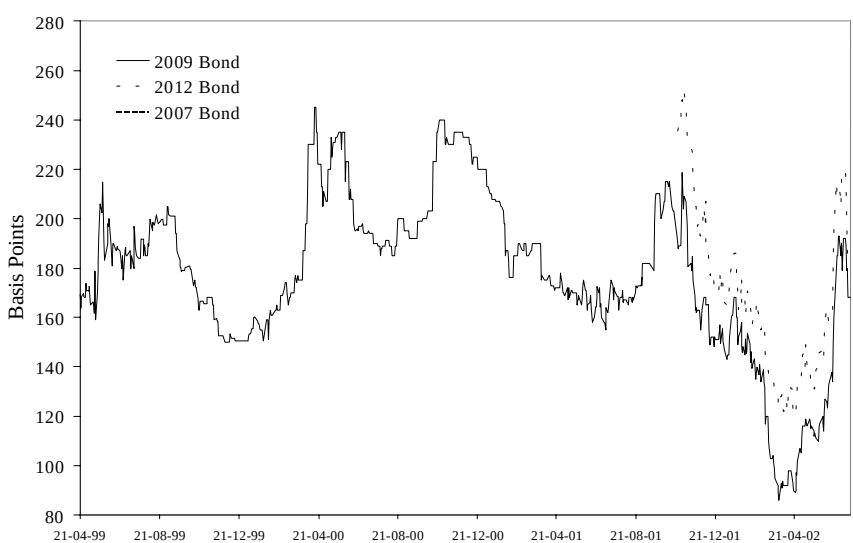
Chilean corporations had begun debt issuance in late 1993 (Compañía Sudamericana de Vapores), process that has continued until recently. Indeed, local companies have accumulated bond issues of US$ 7.5 billion from 1993 up-to-date, equivalent to 25% of the total private external debt (US$ 32 billion). Given these developments in the corporate sector, a key factor behind the first sovereign bond issuance was to set a public benchmark for future corporate bond issues. In fact, corporate debt did not have a high degree of liquidity in international markets, reinforcing the need for a reference value for institutional investors, in particular, for those who were focused on assets from investment grade countries.

Furthermore, most of emerging markets had already the chance to compare the private versus public cost of external financing, since they had already issued sovereign bonds, setting a guideline for corporations in order to assess the best timing for potential bond issuance. Thus, investment banks follow the premium paid by local companies over sovereign spreads as a overall measure of financial soundness of an economy.

As mentioned above, the first issue of sovereign bond made by the Chilean government was carried out in April 1999, for a total amount of US$ 500 million, a release spread of 169 basis points, and a ten year maturity. The following issue was done in mid-October 2001, just a few weeks after the September 11 events in the U.S., amid high overall market volatility. The government had already begun the issuance process in the second half of 2001 and decided to go on with it, considering the advanced stage already achieved at that moment. In the end, a total of US$ 650 million were allocated to high grade investors and registered a release spread of 256 basis points, which was considered a well assessed auction. This bond also had a ten year maturity.

The third issue was carried out in April 2002, which involved not only a new U.S. dollar denominated bond, but also expanded government issues to European markets. In this case, the authority issued a US$ 600 million five-year bond and a € 300 million

Figure 1: Chilean Sovereign Spread



three year bond. Based upon these new bonds, the Chilean government extended the yield curve for international instruments, covering five, seven and ten years horizon denominated in dollars. Finally, the last issue was carried out in January 2003, for a total amount of US$ 1 billion, a release spread of 163 basis points, and a ten year maturity. Figure 1 presents the sovereign spread series for the US dollar bonds.

Emerging markets spreads: investment grade economies

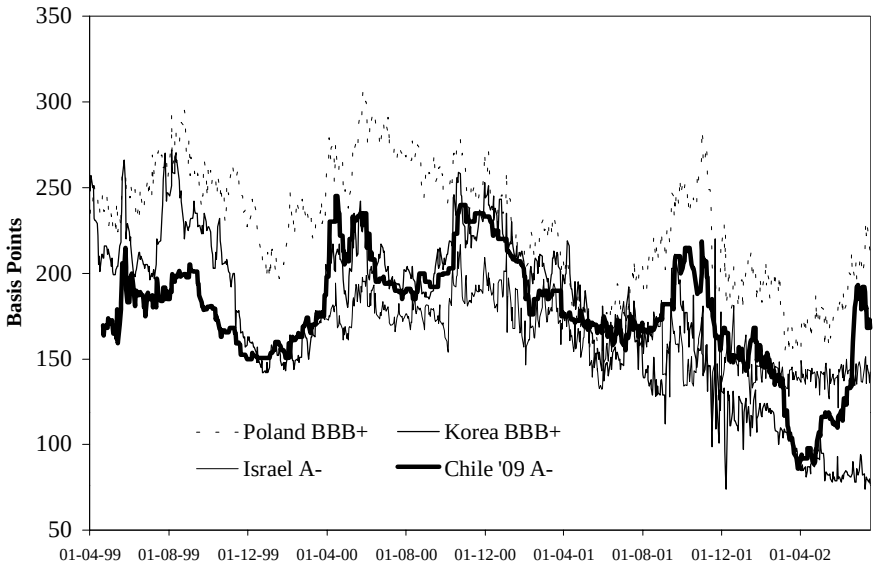
The Chilean economy has outperformed Latin-American countries since mid 1980's, in particular, its strong macroeconomic fundamentals and institutional stability has translated in a stable country-risk rating by both Moody's (Baa1) and Standard & Poor's (A-) during the period under study in this paper.

Indeed, if we compare countries with investment grade category and other Latin-American economies, namely Argentina and Brazil, we find significant differences between sovereign spread levels between 1999 and 2002. As shown in Table 1 and Figure 2, Investment Grade countries presented spreads with 160 to 230 basis points range (Column 2). On the other hand, Latin-American countries showed higher levels, moving within a range from 900 to 1,700 basis points in terms of the mean spread. Furthermore, if we look at maximum levels reached by both groups, we realize that the poorest performer within investment grade economies, i.e. Poland, slightly exceeded 300 basis points in this sample, whereas the poorest performer from Latin America, i.e. Argentina, surpassed by far the 7000 basis points. However, it has

TABLE 1. SOVEREIGN SPREADS INVESTMENT GRADE ECONOMIES

Country	*Mean*	*Std. Dev.*	*Median*	*Max.*	*Min*	*Observations (04/99-07/02)*
			Investment grade			
Chile	178	32	179	245	86	846
South Korea	175	48	189	272	74	860
Israel	164	20	167	217	99	600
Malaysia	162	15	158	195	121	120
Poland	228	36	234	307	148	860
			Latin America			
Argentina	1678	1722	801	7199	515	860
Brazil	865	186	821	1727	626	860

Figure 2: Investment Grade Economies Sovereign Spreads



to be kept in mind the fact that Argentina has declared selective default for its sovereign debt since late 2001.

III. TIME SERIES ANALYSIS OF THE SOVEREIGN SPREAD

The data availability on the sovereign spread for the different sovereign bonds issued by Chile depend on the corresponding issuance date of each bond. For the 2009 bond, the data starts on April 21 1999, and for the 2012 bond the data starts on October 23 2001. Table 2 presents the descriptive statistics for each bond for the corresponding sample period.[1]

TABLE 2. DESCRIPTIVE STATISTICS OF CHILEAN SOVEREIGN BOND SPREADS

Variable	*Mean*	*Std. Dev.*	*Skewness*	*Kurtosis*	*Minimum*	*Maximum*	*No. Obs. (Trading Days)*
CHI 2009	177.9	31.94	-0.499	3.478	86	245	801
CHI 2009	141.8	32.12	0.061	2.128	86	219	178
CHI 2012	169.5	33.85	0.584	2.530	121	253	178

[1] The sample ranges from each starting date up to July 15 2002.

Throughout the paper, the analysis will be centered in the 2009 bond, since it is the bond for which we have a longer history, and therefore a larger number of observations. The average spread for the 2009 bond was 178 basis points, reaching a maximum of 245 basis points in April 14, 2000, and minimum of 86 basis points of March 28, 2002. A more complete characterization of the distribution of the data series can be made by calculating the skewness and kurtosis statistics. By computing this statistics we are able to compare the sample values relative to those of the normal distribution. Under the normal distribution, the value of the skewness statistic[2] should be zero, because the normal distribution is a symmetric distribution, and the kurtosis statistic[3] should be equal to 3. Therefore, if the estimated statistics from the data differ from these values, it is indicative of the fact that the distribution of the sovereign spread departs from the normal distribution. For the 2009 bond we get a value –0.5 for the skewness statistic, which provides evidence of a distribution that has a long left tail, so that the spread is more likely to be far below the 178 basis points mean than above it.

The usefulness of the kurtosis statistic is that it measures the peakedness or flatness of the distribution of spreads. As mentioned above, we need to compare the estimated kurtosis statistic with the value of 3, in order to know if the distribution is leptokurtic (values of kurtosis greater than 3) or platykurtic (values of kurtosis less than 3). For the 2009 bond we observe that the calculated kurtosis statistic is 3.5, above the critical value of 3, which indicates that the distribution is leptokurtotic, so that it has more mass in the tails than a normal distribution, what is usually called fatter tails.

Aditionally, to test whether the series are normally distributed or not, we can make use of the Jarque–Bera test statistic. Under the null hypothesis of a normal distribution the Jarque–Bera statistic[4] is distributed as a χ^2 with 2 degrees of freedom. The advantage of this test is that it is a joint test, since it measures the differ-

[2] Skewness: $S = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{X_t - \bar{X}}{\hat{\sigma}}\right)^3$.

[3] Kurtosis: $K = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{X_t - \bar{X}}{\hat{\sigma}}\right)^4$.

[4] Jarque–Bera: $JB = \frac{N-k}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right)$; H_0: Sovereign Spread $\sim$ Normal; Under H_0: JB $\sim \chi^2_2$.

ence of the skewness and kurtosis of each series of spreads with those from the normal distribution. The estimated value of the Jarque–Bera statistic is 40.9, so we reject the null hypothesis of normality for the 2009 spread at the 1% significance level.

In order to check the time series properties of the data, we need to estimate the autocorrelation (ACF) and partial autocorrelation (PACF) functions to explore the possibility of fitting traditional time series model to the sovereign spread data. Table 3 below presents the ACF and PACF for the spreads of the 2009 and 2012 bonds.

TABLE 3. ACF AND PACF, SOVEREIGN SPREADS

	2009 Bond			*2012 Bond*	
Lag	*ACF*	*PACF*	*Lag*	*ACF*	*PACF*
1	0.990	0.990	1	0.976	0.976
10	0.887	– 0.011	10	0.657	0.059
20	0.774	– 0.007	20	0.355	– 0.002
30	0.646	– 0.072	30	0.187	– 0.074
40	0.491	0.001	40	0.047	0.026
50	0.359	– 0.031	50	– 0.051	0.053
60	0.251	– 0.072	60	– 0.148	– 0.051

The autocorrelation function for the 2009 bond exhibits a very slow decay, which is indicative of a high degree of persistence in the series, since after 60 lags, the effect of a shock to the spread is still present. As a way of complementing the persistence exhibited by the autocorrelation function, we can calculate the half-life[5] of a shock to the sovereign spread. The half life allows us to have an idea about how much time does it take for the sovereign spread to reduce to a half the impact of a shock. A large half–life value means that the process is very persistent, so that any shock to the sovereign spreads takes a long time to die out (as would be in the random walk case). A low half–life value means that the time it takes for a shock to reach half of its original level is shorter, indicative of lower persistence in the process. For the 2009 bond, we get a half life of 40 trading days, that is, it takes 8 weeks to dissipate half of the original shock. On the other hand, for the 2012 bond, we get a half life of 15 trading days, so it takes only 3 weeks to dissipate half of the original shock. It should be

[5] Half-life was calculated solving the following equation: $(\gamma_1)^h = 0.5$.

noted that the samples for the 2009 and 2012 bonds are different, and therefore it is not surprising to find different half lives.

Stationarity

In order to check whether the sovereign spreads are stationary or not, we ran a series of unit root tests to check whether the series were stationary. A time series is stationary if the mean, variance and covariances are constants and do not change over time. If this result holds for the spreads series, we can say that the series are weakly stationary or covariance stationary.[6] The relevance of checking for stationarity relates to shock persistence, in the sense that for a stationary series, a shock to the series has no permanent effect. On the other hand, if we have a non-stationary series, we will find that a shock to the series will actually have a permanent effect.

The unit root tests we ran include the Augmented Dickey Fuller (ADF Tests), the ADF–GLS Tests by Elliot, Rothemberg and Stock, and the KPSS Test. Table 4 below presents the results of the ADF, under two different lag selection criteria, namely the AIC and SIC. The traditional unit root tests fail to reject the presence of a unit root in the series, under both lag selection criteria. Given the low power of the traditional unit root tests against the local alternative of a root close to, but below unity, we ran the ADF–GLS test, which is the most powerful invariant test against the local alternative.

TABLE 4. ADF UNIT ROOT TESTS

	Minimizes AIC				*Minimizes SIC*			
Variable	*ADF* (μ)	*Lag* (p)	*ADF* (τ)	*Lag* (p)	*ADF* (μ)	*Lag* (p)	*ADF* (τ)	*Lag* (p)
CHI 2009	– 2.203	3	– 2.537	3	– 1.977	0	– 2.285	0

†: denotes rejection of hypothesis of a unit root at 1% significance level. ‡: denotes rejection of hypothesis of a unit root at 5% significance level. *: denotes rejection of hypothesis of a unit root at 10% significance level.

From the results given in Table 5 below, we can see that the ADF–GLS gives us some evidence that the spread of the 2009 bond exhibits level stationarity, since the tests rejects the presence of a unit root at the 5% significance level.

[6] Formally, for a time series X_t to be coavariance stationary, we need that the following conditions hold: $E(X_t) = \mu, \forall$ t , $V(X_t) = \sigma^2, \forall$ t and $COV(X_t, X_{t-k}) = f(k)$ $\forall$ t,k .

TABLE 5. ADF–GLS UNIT ROOT TESTS

	Minimizes AIC				*Minimizes SIC*			
Variable	*ADF* (μ)	*Lag* (p)	*ADF* (τ)	*Lag* (p)	*ADF* (μ)	*Lag* (p)	*ADF* (τ)	*Lag* (p)
CHI 2009	– 2.139‡	3	– 2.158	3	– 2.139‡	3	– 2.158	3

†: denotes rejection of hypothesis of a unit root at 1% significance level. ‡: denotes rejection of hypothesis of a unit root at 5% significance level. *: denotes rejection of hypothesis of a unit root at 10% significance level.

In terms stationarity, the last test corresponds to the Kwiatowski, Phillips, Shin and Schmidt (KPSS) test, which is one of the few tests that has a null of stationarity. The results presented in Table 6 presents evidence in favor of level stationarity for the spread series for a lag truncation parameter above 40 trading days.

TABLE 6. KPSS TESTS

		Lag Truncation Parameter (l)								
Variable	*Test*	*1*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*
CHI 2009	η_μ	15.72†	1.59†	0.84†	0.59‡	0.47‡	0.39	0.35	0.32	0.30
	η_τ	6.81†	0.69†	0.37†	0.26†	0.21‡	0.18‡	0.16‡	0.15‡	0.14

η_μ : corresponds to the test under the null that the series is level stationary. η_τ : corresponds to the test under the null that the series is trend stationary. †: denotes rejection of hypothesis of stationarity at 1% significance level. ‡: denotes rejection of hypothesis of stationarity at 5% significance level.

In summary, the traditional unit root tests fail to reject the presence of a unit root for the 2009 sovereign bond spread. However, the ADF–GLS provides evidence that the series is stationary around a certain level, result that is corroborated by the KPSS test, once a we consider a long lag truncation parameter for the purposes of estimating the long run variance of the series.

ARCH effects

The results obtained from the previous section, justify the need for a more parsimonious model in order to explain the behavior of the sovereign spread. Therefore, the following section will be devoted to examine the existence of ARCH effects in the 2009 bond spreads, since from the observation of the series, we can see that it exhibits several episodes where positive (negative) shocks seem to be followed by positive (negative) shocks for some periods

of time, generating several clusters of up or downswings in the series that might be better captured by ARCH type models.

In order to test for the presence of ARCH effects, we use the Lagrange Multiplier test of Engle (1982). Under the null hypothesis, there are no ARCH effects in spreads, and the alternative hypothesis is that ARCH effects are present. The test involves a two step procedure: the first step involves estimating the mean regression, which will consist of a simple AR(1) specification of the form: $\text{Spread}_t = \delta + \phi_1 \text{Spread}_{t-1} + \varepsilon_t$. From this regression we need to recover the series of estimated errors ($\hat{\varepsilon}_t$), which will be used in the second stage. The second stage involves regressing the square of the estimated error terms on a constant and q-lags of the square of the estimated error terms. From this second stage equation, we can test for the presence of ARCH effects by constructing the statistic $T*R^2$ (numbers of observations (T) times the coefficient of determination (R^2)) which has a Chi-square distribution with q degrees of freedom. From the results presented in Table 7, we fail to reject the presence of ARCH effects, so a model that includes ARCH effects would better capture the behavior of the spread.

TABLE 7. TEST FOR ARCH EFFECTS ON SOVEREIGN SPREADS

Variable	*$T*R^2$ Statistic*	*Lags (q)*	*P-Value*
CHI 2009	39.718	3	0.000000
CHI 2012	13.726	2	0.001046

†: denotes rejection of hypothesis of ARCH effects at 1% significance level. ‡: denotes rejection of hypothesis of ARCH effects at 5% significance level. *: denotes rejection of hypothesis of ARCH effects at 10% significance level.

GARCH (1,1) model

In order to capture the ARCH structure of the errors, we will estimate an AR(1) model for the spread (mean equation) of the form:

$$\text{Spread}_t = \delta + \phi_1 \text{Spread}_{t-1} + \varepsilon_t$$

Given this specification, the unconditional mean spread will be:

$$E[Spread_t] = \frac{\delta}{1 - \phi_1}$$

whereas the conditional mean spread will be $E[Spread_t \mid \Omega_{t-1}] = \delta + \phi_1 Spread_{t-1}$, where Ω_{t-1} corresponds to the information set at time t–1. The unconditional variance of the spread under the AR(1) specification corresponds to:

$$Var[Spread_t] = \frac{\sigma^2}{1-\phi_1^2}$$

However, under GARCH type model, we relax the previous assumption of constant conditional variance, and allow the conditional variance to vary over time, so that the conditional variance takes the following general form:

$$Var[Spread_t \mid \Omega_{t-1}] = \frac{h_t}{1-\phi_1^2}$$

Under GARCH(1,1) models the conditional volatility takes the following functional form:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}$$

so we see that the conditional volatility depends on the square of the previous error term and on the previous conditional volatility. The interpretation of the ε_{t-1}^2 term corresponds to the news that have an impact on the conditional volatility. In terms of the sovereign spread series, good news correspond to negative shocks $(\varepsilon_{t-1}^2 < 0)$, since they would reduce conditional volatility, while bad news correspond to positive shocks $(\varepsilon_{t-1}^2 > 0)$, since they would increase conditional volatility. It should be noted that in standard GARCH models, the effect of a shock on conditional volatility depends only on its size, since the sign of the shock is irrelevant. As such, positive and negative shocks will impact conditional volatility in the same way. The parameters in this model should satisfy $\omega > 0$, $\alpha_1 > 0$ and $\beta_1 \geq 0$ to guarantee that $h_t \geq 0$. Thus, the GARCH(1,1) model is covariance–stationary if and only if $\alpha_1 + \beta_1 < 1$. In this case, the unconditional variance of the errors is equal to:

$$\sigma^2 = \frac{\omega}{1-\alpha_1-\beta_1}$$

In order to better capture the existence of ARCH effects, we estimated a model consisting of an AR(1) specification for the spread, and a GARCH(1,1) specification for the error terms. The

results presented in Table 8 show that the values of the parameters satisfy the requirements of covariance-stationarity, since $\alpha_1 + \beta_1 = 0.1132 + 0.8098 = 0.923 < 1$. The value of the unconditional variance of the errors is equal to $\sigma^2 = \frac{\omega}{1-\alpha_1-\beta_1} = \frac{1.5563}{1-0.1132-0.8098} = 20.21$ basis points.

TABLE 8. AR(1), GARCH(1,1) MODEL FOR SOVEREIGN SPREAD

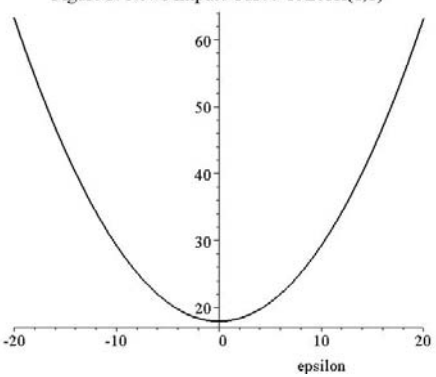
Variable	*Coefficient*	*z-Statistic*
	Mean Equation	
Constant	170.1479	12.55
$Spread_{t-1}$	0.9898	225.79
	Variance Equation	
Constant	1.5563	6.295
ε_{t-1}^2	0.1132	6.843
h_{t-1}	0.8098	31.449

As mentioned before, one of the most interesting aspects of GARCH type models is the fact that we can say something about the effect of the size of shocks on conditional volatility, which is captured by the News Impact Curve (NIC), introduced by Pagan and Schwert (1990) and popularized by Engle and Ng (1993). It basically measures how new information is incorporated into volatility. More precisely, it shows the relationship between the current shock or news ε_t and conditional volatility 1 period ahead h_{t+1}, holding constant all other past and current information. For the GARCH(1,1) model we see that the effect of either positive or negative shocks is symmetric, and so the sign of the shock does not affect the NIC. Figure 3 presents the NIC for the GARCH(1,1) model. We can see that a shock in t–1 of 10 basis points will have an impact of 29.4 basis points on the conditional variance of next period, whereas a 20 basis points shock in t-1 will have an impact of 63.2 basis points on the conditional variance of next period.

One of the caveats of the GARCH(1,1) model is that it does not allow for different responses of the conditional variance in terms of the sign of the shock, so that positive shocks will have a different impact on the conditional variance than negative shocks. In order to check whether positive and negative shocks have a dif-

ferent impact on the conditional variance, we ran the Engle and Ng (1993) test for asymmetric effects. In order to conduct the test, we let S_{t-1}^{-} denote a dummy variable that takes the value of 1 when $\hat{\varepsilon}_{t-1}$ is negative and 0 otherwise, where $\hat{\varepsilon}_t$ are the residuals from estimating a model for the conditional mean of the sovereign spread under the assumption of homocedasticity. The tests examine whether the squared residual $\hat{\varepsilon}_t^2$ can be predicted by S_{t-1}^{-}, $S_{t-1}^{-}\hat{\varepsilon}_{t-1}$ and/or $S_{t-1}^{+}\hat{\varepsilon}_{t-1}$, where $S_{t-1}^{+} = 1 - S_{t-1}^{-}$.[7]

Figure 3: News Impact Curve GARCH(1,1)



The results of the Engle and Ng tests are presented in Table 9. The first column corresponds to the Sign Bias test, which simply tests whether the magnitude of the square of the current shock (ε_t) depends on the sign of the lagged shock (ε_{t-1}). We can see that the sign bias is not significant, which means that the sign of the lagged shock has no significant impact on the magnitude of the shock. The second and third columns present the Negative Sign Bias and the Positive Sign Bias, respectively. These tests examine whether the effect of negative or positive shocks on the conditional variance also depend on their size. The tests show substantial evidence of asymmetric ARCH effects, since both tests show that the size of the either negative or positive shocks do affect the conditional variance differently. This result is corroborated by the last column, the general test, which consists of a joint test of the three previous measures of asymmetry.

[7] The test statistic are computed as the t-ratio of the parameter ϕ_1 in the regression: $\hat{\varepsilon}_t^2 = \phi_0 + \phi_1 \hat{w}_t - 1 + \xi_t$ where $\hat{w}_t$ is one of the three measures of asymmetry, so that $\hat{w}_t = \begin{cases} S_{t-1}^{-} \\ S_{t-1}^{-}\hat{\varepsilon}_{t-1} \\ S_{t-1}^{+}\hat{\varepsilon}_{t-1} \end{cases}$.

TABLE 9. TEST FOR ASYMMETRIC ARCH EFFECTS ON SOVEREIGN SPREADS

	Sign Bias		*Negative Sign Bias*		*Positive Sign Bias*		*General Test*	
Variable	*Test*	*P-Value*	*Test*	*P-Value*	*Test*	*P-Value*	*Test*	*P-Value*
CHI 2009	– 0.196	0.422	–14.99	0.000	34.173	0.000	665.06	0.000

The tests are applied to residuals from an AR(k) model, with k determined by the AIC.

Nonlinear asymmetric GARCH models

Given the evidence of asymmetric ARCH effects, we need to make use of GARCH models that capture this asymmetry. There are several models that are able to capture this asymmetry, such as the Threshold ARCH (TARCH) model by Zakonian (1990), the Exponential GARCH model by Nelson (1991) and the GJR-GARCH model by Glosten, Jaganathan and Runkle (1993). Of the three models mentioned above, we will make use of a GJR-GARCH model in order to capture the asymmetric effects of positive and negative shocks on the conditional variance.

Under the GJR–GARCH model, the conditional variance takes the following functional form, that is obtained from the previous GARCH(1,1) model, but it assumes that the parameter of $\hat{\varepsilon}_{t-1}$ depends on the sign of the shock, that is:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 (1 - I[\varepsilon_{t-1} > 0]) + \gamma_1 \varepsilon_{t-1}^2 I[\varepsilon_{t-1} > 0] + \beta_1 h_{t-1}$$

where $I[\cdot]$ is an indicator function. Under this specification, the conditions for nonnegativeness of the conditional variance (h_t) are $\omega>0$, $(\alpha_1+\gamma_1)/2\geq 0$ and $\beta_1>0$. The condition for covariance–stationarity is $(\alpha_1+\gamma_1)/2+\beta_1<1$.[8] Table 10 presents the results of estimating the GJR–GARCH model.

From the values of the coefficients, we get that the unconditional variance under the GJR–GARCH model is equal to

$$\sigma^2 = \frac{\omega}{\left(1 - \frac{(\alpha_1 + \gamma 1)}{2} - \beta_1\right)} = \frac{0.723}{1 - \frac{(-0.0075 + 0.1259)}{2} - 0.9055} = 20.48 \text{ basis}$$

points, slightly higher than the unconditional variance under the GARCH(1,1).

[8] If this condition is satisfied, the unconditional variance of ε_t is: $\sigma^2 = \frac{\omega}{\left(1 - \frac{(\alpha_1 + \gamma_1)}{2} - \beta_1\right)}$.

TABLE 10. AR(1), GJR–GARCH MODEL FOR SOVEREIGN SPREAD

Variable	*Coefficient*	*z-Statistic*
	Mean Equation	
Constant	168.56	7.00
Spread_{t-1}	0.995	274.3
	Variance Equation	
Constant	0.723	6.62
$\varepsilon_{t-1}^2(1 - I[\varepsilon_{t-1} > 0])$	-0.0075	–1.35
$\varepsilon_{t-1}^2 I[\varepsilon_{t-1} > 0]$	0.1259	6.93
h_{t-1}	0.9055	76.20

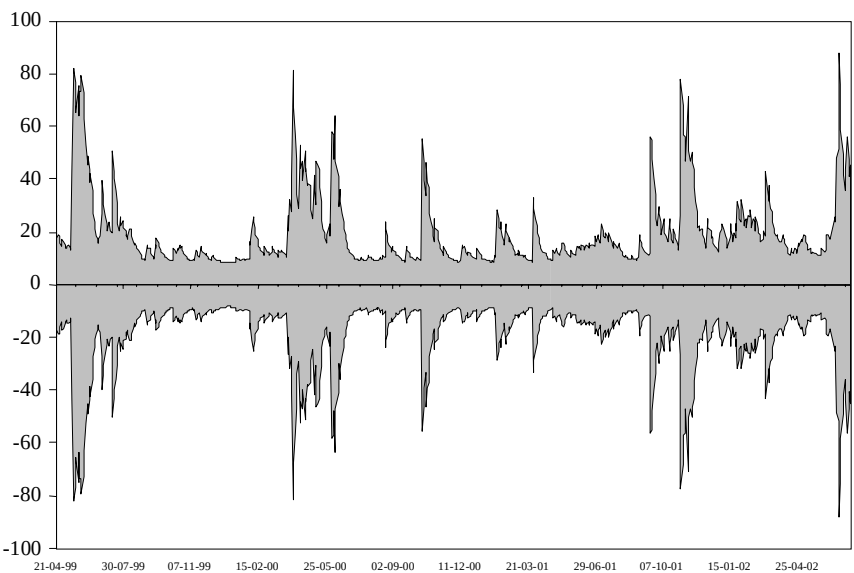
One of the most interesting aspects of GJR–GARCH model is the fact that we can differentiate the effect of positive and negative shocks on conditional volatility. For the GARCH(1,1) model we saw that the effect of either positive or negative shocks is symmetric, and so the sign of the shock does not affect the NIC. However, for the GJR–GARCH model negative shocks have quite a different effect on conditional volatility. In fact, the news impact curve from this model differs significantly form the one obtained for the GARCH(1,1) model. Figure 5 presents the NIC of the GJR–Model, where we see that negative shocks, i.e. that the spread in the current period is below the spread of the previous period, will tend to reduce conditional volatility, while positive shocks, i.e. that the spread in the current period is above the spread in the previous period, will tend to increase conditional volatility, at a faster rate than that predicted by the GARCH(1,1) model. So when the Chilean sovereign spread is rising, it basically becomes a more risky asset, since it will have a higher conditional variance, whereas a reduction in sovereign spread has a very significant effect in actually reducing the conditional volatility. This implies that under times of turbulence in the region, where the Chilean spread might follow upward trends of the sovereign

TABLE 11. EFFECT ON CONDITIONAL VARIANCE (H_T) OF SHOCKS OF DIFFERENT SIGN UNDER GJR-GARCH MODEL

Negative Shock ($\varepsilon_{t-1} < 0$)		*Positive Shock* ($\varepsilon_{t-1} > 0$)	
Basis Points	*Impact on* h_t	*Basis Points*	*Impact on* h_t
–20	17.103	20	70.462
–15	18.415	15	63.202
–10	19.352	10	32.692
–5	19.915	5	23.250

spreads of either Brazil or Argentina due to contagion effects, necessarily resulted in higher volatility, but once contagion effects passed, the Chilean sovereign spread quickly became less volatile. As a way of quantifying these effects, Table 11 below presents the asymmetrical effects of positive and negative shocks on the conditional variance. We can see that a negative shock in t–1 of 20 basis points will reduce next period's conditional variance to 17.1 basis points, while a positive 20 basis points shock in t–1 will have an impact of 70.5 basis points on the conditional variance of next period. The same result can be seen by comparing Figure 4 and Figure 5, which present the conditional variance series for the GARCH(1,1) model and the GJR Model.

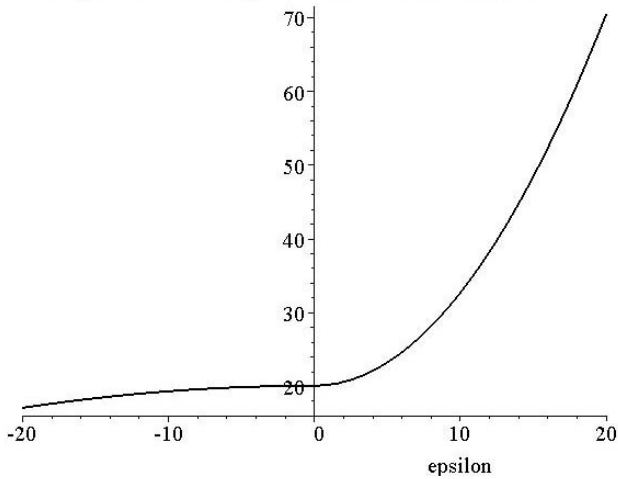
Figure 4: GARCH(1,1) Model, Conditional



From the time series analysis of the sovereign spread series we can first say that shocks seem to be very persistent, so that it takes several trading days for them to dissipate completely. However, the series seems to be stationary around a certain level, once we control for the local to unity unit root of the process. As several other financial time series data, the Chilean sovereign spread series exhibits excess kurtosis, which can be better captured by GARCH type models. In particular, asymmetric GARCH mod-

els, such as the GJR-GARCH have led us to the result that downward movements in the spread are followed by significantly lower volatilities than upward movements of the same magnitude.

Figure 5: News Impact Curve GJR-GARCH Model



The previous analysis has been based on the daily data of the sovereign spread, and involved mainly the use of time series tools. However, the level of the spread is mostly determined by macroeconomic fundamentals of each country. In the next section, we estimate a model that explicitly takes into account the influence of such factors on the level of the spread.

IV. SOVEREIGN SPREAD FUNDAMENTALS ANALYSIS

Regardless of the benefits of making use of high frequency data in terms of modeling the behavior of sovereign spreads in the very short run, the main driving forces of the medium to long run spread levels charged to emerging market economies are essentially determined by macroeconomic fundamental variables. It is therefore necessary to analyze how these variables have determined the path followed by the Chilean sovereign spread. This section will be dedicated to explore the relationship between a set of relevant macroeconomic fundamental variables and the sovereign spread level.

Fundamental variables

The variables to be included as determinants of the sovereign spread can be grouped into three broad categories. The first category corresponds to variables related to Chile's external financial position. The second category includes measures of external and domestic performance, and the third category corresponds to international interest rates.

The first category of variables corresponds to Chile's external financial position, and the purpose of including these variables is to capture external investor's assessment on the country's position. It is important to differentiate between solvency problems and liquidity problems. Our focus will be on liquidity, rather than on solvency problems. In order to have a measure of potential liquidity problems, we need to take into account elements such as outstanding external debt, both public and private, external liquidity measured by the level of international reserves and debt composition in terms of its maturity. Countries with higher overall levels of external debt face higher spreads, while countries with lower levels of outstanding debt face lower spreads. The hypothesis behind this relationship is that an increase of external commitments involves higher pressure over external liquidity available in an economy. Increases in external debt should mean higher risk of the assets issued by the country increasing its debt, thereby forcing investors to require a higher yield on sovereign and corporate bonds.

But not only the overall level of external debt is relevant for the spread charged to a certain country. As important as the overall level of external debt is its maturity structure, since a higher concentration of short term debt is viewed as seriously compromising the country's international liquidity. Therefore, even though an economy might exhibit an overall stable relative level of external debt, such as the one measured by the Total Debt to GDP ratio or Total Debt to international reserves ratio, a higher concentration in short-term debt would necessarily translate into a higher spread.

The second set of variables corresponds to variables related to the economic performance of the Chilean economy. Regarding external performance, the behavior of exports becomes a key indicator, since it reflects the country's ability to generate international resources, that in part might be used to serve the external debt. Chile's overall performance, as a small open economy, is highly dependent on the evolution of its export base, so that

higher performance in terms of exports should lower the spread, as the country is able to generate a higher level of international resources. Regarding domestic performance, domestic growth should reduce sovereign spread levels due to several reasons. First, higher domestic growth reflects a higher level of productivity relative to other emerging market economies, impacting positively the price of sovereign bonds, and reducing spread levels. Second, higher domestic growth should also translate into higher revenues by the government, increasing the resources that might be used to service the debt, and also reducing the level of the sovereign spread.

The third set of fundamental variables correspond to international interest rates, where we will focus on the effects of U.S. interest rates.[9] In addition to the direct impact of changes in U.S. interest rates on rates in developing countries, sovereign spreads have tended to move in the same direction as the changes in U.S. interest rates. This effect on developing country spreads was seen clearly in 1994 when a tightening of U.S. monetary policy was reflected in a substantial widening of spreads, and in 1998, when an easing of U.S. monetary policy in response to the flight to quality and the concerns about a U.S. credit crunch associated with the Russian default and the near demise of Long-Term Capital Management (LTCM) helped to restore global liquidity conditions and to reduce sovereign spreads somewhat. Most of these analyses have tended to explore the role of global liquidity conditions, as proxied by a specific yield on a U.S. treasury security, on sovereign bond spreads.

From a theoretical perspective, a rise in U.S. policy interest rates could lead to an increase in emerging market spreads for several reasons. To the extent that emerging market bonds are risky (there is a probability of default), the yield on emerging market bonds would have to rise by more than any rise in the risk-free rate. To illustrate, if r and i represent the interest rate on the risk-free asset and the risky asset, respectively, and p is the probability of repayment on the risky asset, then the equilibrium condition is:

$$(1+r) = p \times (1+i) + (1-p) \times 0$$

The interest rate spread, S, defined as the difference between the rate on the risky asset and on the risk-free asset, in equilibrium is then:

[9] Part of this section was taken from Arora and Cerisola (2001).

$$S = (1 + r) \times \frac{(1 - p)}{p}$$

and its derivative with respect to r is $(1 - p) / p$, which is positive as long as $p < 1$. This says that as long as there is some risk of default, the rate on the risky asset will have to rise by more than any rise in the risk-free rate in order to compensate investors for the risk. A rise in U.S. rates could also raise emerging market spreads through its effects on the ability of debtor countries to repay loans. A rise in U.S. rates would tend to increase debt-service burdens in borrowing countries, which would reduce their ability to repay loans. In addition, as noted by Kamin and Kleist (1999), a rise in U.S. rates could reduce investors' appetite for risk, leading them to reduce their exposure in risky markets, in turn reducing available financial resources in borrowing countries. In terms of the above illustration, if the probability of repayment is a negative function of the risk-free rate ($p = p(r)$, with $p' < 0$), then the first derivative of S with respect to r is:

$$\frac{dS}{dr} = \left(\frac{(1 - p)}{p} \right) - \left((1 + r) \times \frac{p'}{p^2} \right)$$

which is positive (since $p < 1$ and $p' < 0$). This says that a rise in the risk-free rate raises the spread both because of the risk of default (the first term) and because that risk rises as the risk-free rate goes up (the second term). From a theoretical point of view, changes in U.S. interest rates, or likewise in global liquidity conditions, would be expected to influence positively country risk and sovereign spreads in developing countries.

In order to measure the effect of U.S. monetary policy we will make use of the federal funds rate, instead of the yield on a U.S. treasury security. Most of the specifications adopted so far in the literature have proxied U.S. monetary policy by the yield on U.S. treasury securities. However, shocks to U.S. treasury yields are not necessarily the result of changes in U.S. monetary policy.

Finally, in order to capture the potential effects of the new issuance's, and the effect it might have in the path followed by the spread, we included two dummies for each new issue, namely, October 2001 (2012 bond) and April 2002 (2005 and 2007 bonds). The purpose of this dummy variables is to capture an increase in the spread due to portfolio balance considerations, so that a larger amount of outstanding debt should necessarily imply a jump in the sovereign spread, since investors would be willing

to hold a larger amount of debt only if they are compensated through a larger premium.

Fundamentals model and results

The model specification to be estimated can be summarized as follows:

$$Spread_t = \alpha_0 + \alpha_1(External\ Financial\ Position\ Variables)_t + \alpha_2(Performance\ Variables)_t + \alpha_3(U.S.\ Interest\ Rates)_t + \alpha_4 Dummies + \varepsilon_t$$

The estimation process considered a number of alternative specifications, in particular, for international liquidity and external financial position. Several indicators related to the international financial position of Chile were included in the estimated equations. These included external debt interest payments, portfolio investment flows from non-resident and alternative international financial prices. However, since they were not statistically significant, they were are not reported. Table 12 presents the results of the estimation of four alternative specifications, which include different measurements for the external financial position of the Chilean economy.

In terms of the variables related to Chile's external position, we see that the levels of either the total short term debt, or the total external debt are not statistically significant in determining the level of the Chilean sovereign spread. However, if we use the ratio of short term debt to international reserves, which corresponds to the most used indicator to measure international liquidity, we can see that it becomes significant in explaining the level of the sovereign spread, so that an increase in the short term debt to reserves ratio will necessarily imply a rise in the sovereign spread, due to the reduced international liquidity. The same result holds if we use the ratio of total external debt to international reserves as a measure of domestic international liquidity, since the parameter is now positive and statistically significant, but of a lower magnitude than the parameter obtained for the short term debt to reserves ratio, as shown by equations 2 and 4.

Regarding the effect of performance measures, external performance measured by exports had the expected negative sign, so that a positive trend in exports would reduce the sovereign spread. This result is consistent within the four specifications of the empirical model, in terms of statistical significance, parameter signs and parameter values. Turning to domestic performance, domestic growth, measured by the monthly index of economic ac-

TABLE 12. DETERMINANTS OF CHILEAN SOVEREIGN SPREAD

Variables	*Equation 1*	*Equation 2*	*Equation 3*	*Equation 4*
Short Term Debt	1.42			
	(1.62)			
Short Term Debt/Reserves		76.47		
		(2.04)		
Total External Debt			0.95	
			(0.16)	
Total External Debt/Reserves				63.64
				(2.07)
Exports	– 1.50	– 1.31	– 1.32	– 1.45
	(– 2.35)	(– 2.13)	(– 2.02)	(– 2.36)
IMACEC	– 13.02	– 12.44	– 13.28	– 17.56
	(– 1.69)	(– 1.65)	(– 1.42)	(– 2.29)
Fed Funds Rate	13.45	16.67	15.12	17.47
	(5.63)	(7.61)	(6.59)	(7.48)
Dummy 2012	77.63	76.07	77.78	73.85
	(3.86)	(3.86)	(3.65)	(3.75)
Dummy 2007	– 47.93	– 46.91	– 45.31	– 50.51
	(– 2.35)	(– 2.36)	(– 2.12)	(– 2.53)
R^2	0.73	0.74	0.71	0.74
Adjusted R^2	0.68	0.69	0.65	0.69
N. Obs.	38	38	38	38

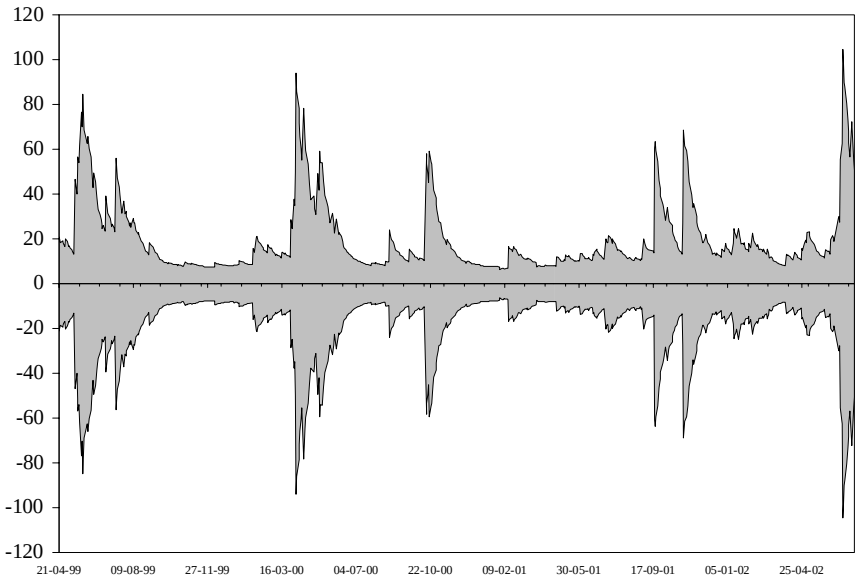
NOTE: t-stats in parenthesis.

tivity (Imacec), the estimated coefficients are consistently negative for the four estimated models, but the estimated coefficient is only significant in equation 4. Higher domestic growth should then results in lower sovereign spreads, since the likelihood of timely repayment increases.

Turning to international interest rates, the federal funds rate shows a positive and statistically significant coefficient in all equations, as predicted by the theoretical considerations described above. A rise in the fed funds rate raises the spread both because of the risk of default and because that risk rises as the risk-free rate goes up. Therefore, changes in U.S. interest rates, or likewise in global liquidity conditions, would be expected to influence positively the Chilean sovereign spreads.

A final word on the 2012 and 2007 dummies, which take into account the most recent issues undertaken by the Chilean government. The coefficient on the 2012 dummy shows a direct positive and statistically significant impact on the sovereign spread. Such a jump in the spread could in part be explained by portfolio

Figure 6: GJR-GARCH(1,1) Model, Conditional Variance



balance considerations, but it should also be noted that the 2012 bond was also issued right after the 9/11 events, and so in part it reflects the market turbulence prevailing in those days, and not purely the portfolio balance effects on the new issuance. On the other hand, the 2007 dummy presents a negative effect on the sovereign spread of the 2009 bond. In fact, the issue spread was influenced by the very favorable conditions regarding the prevailing market prices and a high yield oriented demand could have caused the change in sign of the 2007 dummy, thus showing a decreasing one time effect over the 2009 bond spread.

V. CONCLUSIONS

Chilean sovereign bonds have had a rather short but quite interesting history, marked by world and regional turbulence since the first bond issuance in April 1999. Not only the Asian crisis affected global markets, but also Brazil and Argentina. So a closer look at either the daily behavior of the spread series through time series models, or at the medium to long term determinants of the sovereign spread series is granted, since the sovereign spread has

become the most clear indicator of the cost of external financing for the Chilean economy as a whole.

Time series analysis of the spread show that shocks seem to be very persistent. However, the series seems to be stationary around a certain level, and it exhibits excess kurtosis, which can be better captured by GARCH type models. In particular, asymmetric GARCH models, such as the GJR-GARCH have led us to the result that downward movements in the spread are followed by significantly lower volatilities than upward movements of the same magnitude.

In terms of fundamentals analysis, using a model based on a reduced set of variables, we are able to explain the medium to long term behavior of the level of the spread. These variables include liquidity indicators (short term debt/reserves ratio), economic performance variables (external and domestic), and U.S. interest rates. A higher short term debt to reserves ratio, i.e. lower international liquidity, should increase the sovereign spread. Improvements in either domestic or external performance should also reduce the spread of the sovereign bond. And finally, an increase in the Fed Funds rate, i.e. a tightening of the U.S. monetary stance, should increase the sovereign spread, as global liquidity is reduced.

Appendix 1

VARIABLE DEFINITIONS

Variable	***Definition***
Short-term Debt	Monthly change, 3 month moving average
Short-term Debt/Reserves	Ratio of short-term external debt to international reserves
Total External Debt	Monthly change, 3 month moving average
Total External Debt/Reserves	Ratio of total external debt to international reserves
Exports	Monthly change, 3 month moving average
IMACEC	Monthly change, 3 month moving average
Fed Funds Rate	Federal Funds Rate, Monthly Average
Dummy 2012	Takes value 1 for October 2001
Dummy 2007	Takes value 1 for March 2002

SOURCES: Central Bank of Chile, Bloomberg.

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Enrique Alberola
Luis Molina

What does really discipline fiscal policy in emerging markets?: the role and dynamics of exchange rate regimes

1. INTRODUCTION

Traditionally, a strong emphasis on the causes of the traditional high inflation in emerging countries, and in particular in Latin America, has been placed on the fiscal dominance hypothesis. In emerging market economies, the argument goes as follows: the ability to obtain revenues through the fiscal system is weak; as a consequence, traditionally the financing of the deficits has been partially done through money creation by the Central Bank (seignoriage revenues), which in turn leads to higher inflation.

The harmful effects of this practice on price stability and long-term growth contribute to explain that the quest for macroeconomic stability has typically had in the choice of the exchange rate regimes one of its central elements. Many countries based

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their programs of economic stabilization on regimes of rigid or semi-rigid exchange rates. The rationale for this strategy is clear: fixing credibly the exchange rate allows to tie down inflation expectations; this induces a more disciplined behavior in economic agents, and in particular, on the fiscal sphere, since a fall in inflation should drastically reduce seignoriage revenues, promoting fiscal discipline.

Nevertheless, extensive empirical evidence has challenged this theoretical prior. In figure 1 we observe that fixed exchange rate regimes do not to improve primary balances, which has been the most used proxy for fiscal discipline, even if inflation –and therefore monetary seignoriage– are substantially reduced.[1] It can be argued, as we do, that observed primary balances fail to capture the effect of pegs on fiscal discipline, since they miss the impact of seignoriage. However, when this problem is addressed by defining a shadow balance which account for the effect of seignoriage on the fiscal balance –see Annex 1– the outcome is also unclear as displayed in the last column for each regime

Why do fixed exchange rates seem to fail in disciplining fiscal policy? Bits of such theory have been forwarded by several authors, particularly for the case of Latin America. Most relevant is the contribution by Tornell and Velasco (1998), who show that fixing the exchange rate provides a free lunch in the short run in terms of inflation stabilization and reduces the incentives for fiscal discipline, relative to other stabilization programs based on flexible exchange rates. In other context, Gavin and Perotti (1997) and Gavin et al. (1997) have emphasised the relevance of borrowing costs on the behavior of fiscal authorities, which may also be related to the existing exchange rate regime. Finally, an extense literature, recently surveyed by Calvo and Vegh (1998), has analysed the expansionary impact of fixing the exchange rate: exchange-rate-based stabilization schemes usually bring about rapid disinflation (due to the anchoring of external prices), an economic expansion and a fall in real interest rates, which tend to reduce deficits, but these expansions are followed by recessions (boom and bust cycles).

Taking into account these disperse contributions, this paper attempts to articulate a comprehensive hypothesis to explain the failure of fixed exchange rates to reduce fiscal imbalances and to test it empirically. The hypothesis revolves around the idea that

[1] These data refer to emerging market economies in Latin America and East Europe. Details on the sample are given in the annex.

even if the pegs impose monetary constraints to finance the deficits, other offsetting effects relax both the revenue-raising and financial constraints for the government. The first of these effects is related to the cycle and, in particular to the 'boom and bust' consequences derived from exchange rate stabilization. The second is through more favorable financing conditions after an exchange rate peg is implemented.

The structure of the paper is as follows. In section two, the links between the fiscal constraint of the government and fiscal discipline are explained, and the concept of shadow balance introduced. In section 3, we setup our hypothesis, which is developed empirically, after some econometric consideration (section 4) in a two-stage approach in section 5. Finally, the hypothesis is made more robust by considering the dynamics triggered by pegging the exchange rate on the economy in section 6. The final section draws some conclusions.

2. FISCAL CONSTRAINTS AND THE DETERMINANTS OF FISCAL DISCIPLINE

The government budget constraint exposes the identity between the fiscal financing needs and sources, expressed in real terms and as a ratio of GDP:

$$-pb + (r - g)d \equiv -fb \equiv \dot{d} \tag{1}$$

The observed fiscal balance (fb) consists of the primary balance (pb) minus the interest payments on the stock of debt in the hands of the private sector (d), whose magnitude depends on the difference between the real interest rate (r) and the rate of growth (g). Fiscal balance is financed by increases in the stock of debt. Solving for the primary balance we derive the fiscal constraint of the government:

$$\left[\dot{d} - rd\right] + gd \equiv -pb \tag{2}$$

Note that seignoriage revenues (denoted by m) are not included in this expression, but in fact the *observed* primary balance already conveys seignoriage revenues, which accrue to the public accounts during the fiscal year, although they are not directly observable. Indeed, with no seignoriage the registered balance would have been lower. Furthermore this consideration is particularly relevant when the focus is to investigate the impact of

the exchange rate pegs on fiscal discipline, as they constrain monetary policy and seignoriage. Therefore, we propose a modification to the above expression to take into account 'ex post' the seignoriage revenues, by substracting them from the primary balance. We denote such concept as shadow balance: $sb = pb\text{-}m$. Clearly, this measure has some problems since does not strictly correspond to the fiscal balance that would have been registered if no seignoriage would have been possible, since it can be correctly argued the observed primary balance is to a large extent endogenous to the ability to raise seignoriage. However, this caveat is not possible to circumvent since it is a counterfactual. Modifying identity (1) we obtain an equivalent fiscal constraint with the shadow balance:

$$m + \left[\dot{d} - rd\right] + gd \equiv -sb \tag{3}$$

In spite of the mentioned problem, the shadow balance is our alternative gauge for fiscal discipline, and written in this manner, expression (3) not only illustrates the sources of financing fiscal disequilibria but also, when it is read from left to right, the determinants of fiscal discipline: a reduction in the right hand side implies a constraint to the public finances and is due to induce higher fiscal discipline, and vice versa.

The first element is monetary financing through seignoriage revenues (m). Indeed, revenues from seignoriage have typically been considered a special and heterodox form of taxation to finance deficits. Sargent and Wallace (1981) even suggested that inflation is a fiscal, rather than a monetary phenomenon because monetary policy is dominated by the financing needs of the government (the fiscal dominance hypothesis). Here lies the gist of the argument to link fixed exchange rate pegs with fiscal discipline: since pegs limit monetary autonomy they will reduce seignoriage, forcing to larger fiscal discipline.

The impact on fiscal discipline of the financing is captured by the second term ($\dot{d} - rd$). The increase in debt net of interest payments can be interpreted as the ability and scope to attract funds, both in the domestic and external markets, to cover the financing needs of the government. Financing constraints are determined by two intertwined aspects: the increase in indebtedness, ($\dot{d}$), and the cost and burden of debt (rd). An increase in the former reflects, under this view wider access and a relaxation of the financing constraint; on the contrary increases in the cost and burden of debt hardens the constraint.

The third term underscores the impact of growth, (g), and the cycle on fiscal discipline, suggesting that higher growth relaxes fiscal discipline. In expression (2) is at work the fact that higher rates of growth reduce the ratio of debt to GDP facilitating financing of the deficit, but this factor should be interpreted more loosely. Indeed, in expansions revenues are expected to increase and the fiscal constraints for the government would be relaxed.[2]

3. THE HYPOTHESIS

The relevance of seignoriage and of the fiscal dominance hypothesis in the literature explains the emphasis on the first factor in the attempts to explain fiscal discipline in emerging countries. From here, it follows that fixing the exchange rate should guarantee higher fiscal discipline: under a fixed regime the monetary creation process is constrained, and therefore monetary seignoriage is reduced and fiscal discipline enhanced.

However, in a previous paper (Alberola and Molina (2001)) we showed that, although the first hypothesis holds, the second does not;[3] that is, primary deficits are not significantly reduced when monetary seignoriage shrinks. The lack of a disciplining effect coincides with other evidence provided by Gavin and Perotti (1997), Tornell and Velasco (1998) or Calvo and Vegh (1999) which also used the primary deficit as measure of fiscal discipline.

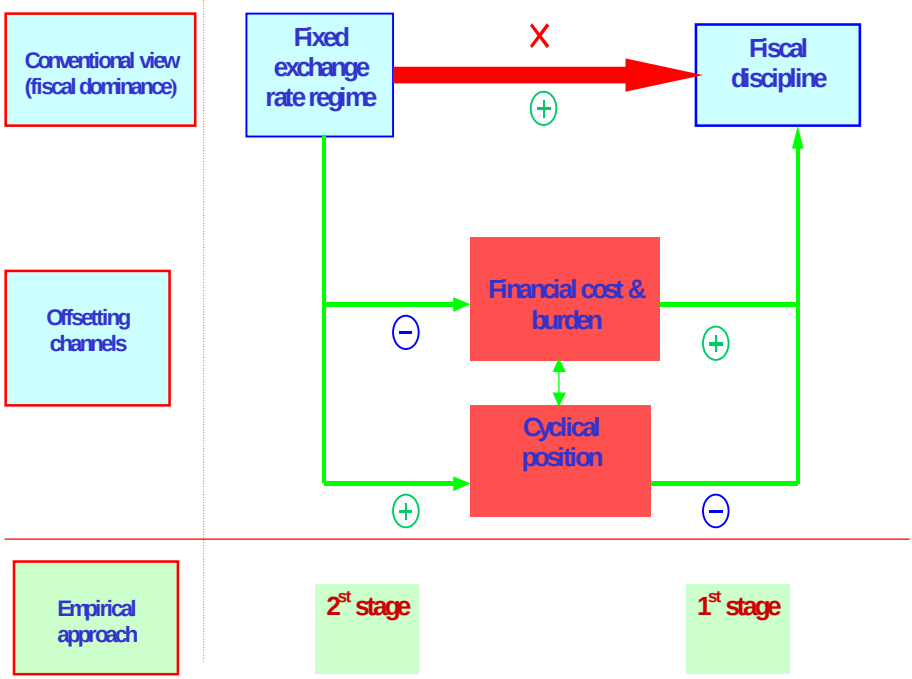
A first possibility for this result is to argue that primary deficits do not properly convey fiscal discipline and in particular the impact of pegs therein, hence our alternative definition of shadow balance.

Yet, provided the alternative gauge of fiscal discipline does not solve the problem, we should be ready to provide a hypothesis to

[2] In emerging countries, expenditures are not expected to depend so much on the cycle because the main cyclical item in expenditures in developed countries, unemployment benefits are not generalized in emerging countries. However, other indirect channels as higher support to firms or consumers in cyclical downturns could be possible.

[3] In that paper, the proposed explanation was that even under a fixed regime financing the deficit through the central bank is feasible, at least in the short run. Indeed, we showed that fiscal seignoriage (measured as the transfers of money from the central bank to the government) is not constrained by fixing the exchange rate and, more importantly, that the primary deficit is negatively and significantly correlated with fiscal seignoriage, endorsing the idea that fiscal discipline is enhanced when fiscal seignoriage is reduced.

explain the result. We argue in what follows that, fixed exchange rates regimes relax both the revenue-raising and the financing constraint of the authorities and that this more than compensates its potential disciplinary effects through reduction of seignoriage. The following *chart* outlines our hypothesis, which is developed in a two-stage approach.



The *first stage* focuses on the actual effectiveness of the cyclical and financial constraints on fiscal discipline. The propositions to test in this first stage are:

i) A favourable cyclical position, mostly by increasing revenues, relaxes fiscal discipline. A strong version of this hypothesis would imply a negative relationship between the cycle and fiscal discipline, but this is perhaps a too strong assumption. Rather, what it is to be expected is an increase in primary expenditures, induced by higher revenues. Note that this is contrary to conventional wisdom, whereby expenditures should tend to be countercyclical, due to the operation of automatic stabilizers as unemployment benefits. These stabilizers are all but absent in emerging countries.

ii) *Reduced costs of borrowing and lower burden of debt relax fiscal discipline*, as hinted by Gavin et al. (1997). Therefore, we would expect to find a negative relation between the fiscal balances and the financing costs. Note that this is a quite strong hypothesis. Indeed, if causality is admitted to run in the opposite direction –from the fiscal balance to the borrowing cost– it should be expected a positive correlation between these variables.

It is important to note that both expected effects may be closely intertwined. Lower borrowing costs are expected to be expansionary and, viceversa, economic expansions may have an impact on borrowing costs. In a traditional IS-LM framework the impact would be positive, but in emerging markets confidence considerations (high growth reinforcing economic confidence) might play a dominant role. This interconnection is also addressed in the empirical analysis.

The *second stage* tests the link between the exchange rate regime and the determinants of fiscal discipline. The propositions to test are:

i) *Fixed exchange rates increase the level of activity*, due to the anchoring of expectations, the reduction of real rates and large capital inflows, which generate an expansionary cycle.

ii) *Fixed exchange rate regimes reduce the cost and burden of borrowing for the government*, due to different factors, such as the disinflationary impact or the credibility of the regime, decreasing the risk premium.

Note that most of these factors are expected to operate primarily at the inception of the exchange rate. The time dimension, underlying the boom and bust literature mentioned in the introduction, is hence bound to play a central role in our analysis.

4. DATA AND ECONOMETRIC CONSIDERATIONS

Before starting the analysis it is important to make several considerations regarding the database and the variables and the econometric techniques used.

The first regards to the choice of the sample, which is explained in more detail in annex 1. We take observations of 32 emerging market economies and transition countries, of which 18 belong to Latin America, 11 are European states in transition, plus Israel, Russia and Turkey. The sample for Latin American

countries, Turkey and Israel runs from 1972 to 2001, and for the European countries it starts, in the majority of cases, in 1990. From this wide sample we have excluded the observations corresponding to inflation and seignoriage outliers, leaving a base sample of 598 observations. However, we use both samples, the one with the outliers and the one without them, to test for the robustness of the hypothesis.

The definition of the variables is as follows:

i) *Fixed regimes* identification is explained with more detail in the annex. The approach adopted is somewhat different from the IMF's, whose strict definition of fixed exchange rate regimes leaves out important stabilization efforts through semi-fixed arrangements, such as crawling pegs. Therefore, an alternative classification is produced, in which by examining more closely the nature of the exchange rate regimes, we expand the proportion of fixed exchange regimes from 49% (which we obtained from IMF's strict definition) to 60%.[4] In doing the estimation regimes are defined by a dummy variable which takes the value of 1 for fixed regimes and 0 for the flexible cases. When there is a shift in regime, we assign a value of 1 for the year in which the change takes place if it is implemented in the first six months, and a value of 1 for the next year if it is implemented from July onwards.

ii) The choice of the variable which gauges *fiscal discipline* raises difficult questions. Clearly, fiscal statistics in emerging markets are typically fuzzy, with items off-balance and 'skeletons'[5]. Even more relevant is the variable to define fiscal discipline. For the reasons put forward above we would in principle, prefer the shadow balance, that is, the primary balance net of estimated seignoriage revenues, which are measured, following the traditional definition by Fischer (1982) as the increase in the monetary base relative to nominal GDP. However, this way of computing the shadow balance has some caveats: not only, as observed above, primary balance is to some extent endogenous to

[4] Recently Levi-Leyati and Sturzenegger (2002) and Reinhart and Rogoff (2002) have proposed alternative definitions. We plan to check our results with their database, but they roughly correspond to ours. Nevertheless, the results presented in the paper are robust to a change in the definition of the exchange rate regime (using IMF's one yield very similar outcomes).

[5] Gavin and Perotti (1997) overcome this problem with a revised database, but we keep on national accounts.

the ability to raise seignoriage, but also the definition of monetary seignoriage is an approximation which may not precisely apprehend the actual monetary financing of deficit. For this reasons, it is convenient to present the results for both the shadow and primary balance. This also facilitates comparison with previous contributions since their results have always been presented in terms of primary balances.[6] We also use the components of the fiscal balance, revenues and primary expenditures, to gain further insight on the behavior of the public sector accounts.

iii) The *effect of the cycle* is conveyed by the change in output gap relative to GDP. The trend GDP is filtered out through and H-P decomposition. The alternative of using growth rate of GDP and introducing individual effects in the regressions yields very similar results, but given the different marked phases of growth in the region the output gap changes probably captures better the cyclical position.

iv) Finally, we use two different variables to account for the *cost and burden of borrowing* which act as proxies of the financing constraints: interest payments of the public debt and the implicit interest rate on this total debt. Higher interest payments –determined by the yield paid and the debt to finance- are expected to be associated with tighter financial constraints, either because rates will tend to increase when financing condition harden or because higher levels of indebtedness make financing increasingly difficult, or both. A second option is to dispense with the level of indebtedness and to use the implicit rate on total public debt, calculated as total interest payments divided by total public debt, that is, as the average interest rate on outstanding public debt.[7]

All the variables, but the regime dummies, are expressed in terms of GDP. The final set of considerations is of econometric nature.

First, the database suggests the use of panel techniques in the analysis. In panel data estimation, individual effects are customarily included, but we consider that in some of our regressions this

[6] Overall fiscal balances have also been typically used, but to avoid excessive complexity in the table we do not present the results for this variable.

[7] The increase in public debt, which appear in the budget constraint of section two is an inappropriate proxy because it may signal itself fiscal indiscipline.

is inadequate. In particular, when regressing the variables against the regime dummies the results on the regression would be distorted; since introducing individual effects implies to subtract the cross-country averages from the variables in the regression, this would imply that what is regressed is the (cross-country) deviation of the dependent variable on the (deviation of) the regime dummy, therefore distorting the relevant relation to explore which is the level of deficit on the exchange rate regime.[8] In the rest of the cases we include individual effects.

Second, the series show important inertia and the issue of unit roots may become a concern. Therefore, in the regressions on the exchange rates dummies the lagged value of the dependent variable has been included. When we implement the instrumental variables technique, we address this problem using first order autoregressive correction for the residuals.

Third, heteroskedasticity, which leads to an important loss of efficiency in estimation, although the estimates are still unbiased and consistent, is another problem which may arise in the data. Since we are interested in the significance of the parameters rather than in their value, it is important to correct the estimations for heteroskedasticity. This is done by controlling for cross-country variances. Related to this, the wide volatility advises to make use of weighted least square (WLS) estimation which place proportionally lower weight to more extreme observations. Even so, in a sample with several episodes of hyperinflations and depressions, outliers are large. As we note before, the sample used in estimation filters out the upper ten per cent of the inflation series, although we also have used the whole sample to test for the robustness of our hypothesis.

Finally, the issue of endogeneity and inverse causality is tackled. In the hypothesis presented underlies a causality from left to right in the chart (from the exchange rate regime to the cycle and financing constraint and from these to fiscal discipline). But it could be argued, for instance, that exchange rate regimes and fiscal discipline or borrowing costs are endogenous, that is, that they are determined at the same time, and consequently it is impossible to establish a clear relationship between them; or that the evolution of borrowing costs is a consequence of fiscal discipline,

[8] Note also that, if individual effects were considered, there would be no difference between countries with only one type of regime in the whole sample, since the resulting dummy value (which would be defined as deviation from the mean value of the regime) would be in both cases equal to zero.

and not vice versa as we suggest. Several venues are used. In particular, to solve the endogeneity issue we instrument the variables by the lagged value of the regressor and, in some cases, by an 'external' instrument (the current account balance as a percentage of GDP). Then we perform some Granger type causality tests. Also, the sign of the relationship may help to reveal the direction of causality. The focus on the temporal effects of exchange rates in the last section helps to address these problems, too.

5. EMPIRICAL EVIDENCE

Fixed exchange rates and fiscal discipline. The direct channel

Figure 1 in the introduction showed graphically that fixed regimes reduce inflation but they fail to improve fiscal discipline. Table 1 formally confirms the muted effect of fixed exchange rate regimes on fiscal discipline. First, we confirm that seignoriage revenues are reduced under fixed regimes.[9] However, when the two measures of discipline are regressed against the regime, the parameter of the dummy is not significant, and it even takes a negative value for the primary balance. Neither is a significant effect found on the components of the primary balance: revenues and primary expenditures.[10] All in all, fixing the exchange rate does NOT induce discipline on fiscal policy.

First stage: factors determining fiscal discipline

The levers of fiscal discipline under our hypothesis are the cyclical position and the financing constraint. As mentioned above, both factors may be intertwined, so table 2 displays the joint impact of the cycle, measured as changes in the output gap, and our proxies for the external constraint on fiscal discipline. We combine the cyclical position with both interest payments and the implicit interest rate, so that there are three different regressions for each of the fiscal discipline variables. Furthermore, for each re-

[9] For the sake of completeness, we have also regressed the fiscal discipline variables on seignoriage. Only the shadow balance is largely significant, but this is expected since the shadow balances is constructed using seignoriage revenues.

[10] When maintaining the full sample (with outliers) the impact on revenues is found to be negative and significant. The large reduction in inflation that countries experiences when fixing the exchange rate could lie behind this result.

gression the results, using both OLS and instrumental variables are displayed. The instruments used are the lagged regressors and the current account balance, and the results are very similar in both specifications.

As shown in the table 2.a, we do not find any relation between the cyclical position of the economy and the primary balance. This is so because the cycle tends to increment fiscal revenues but also, primary expenditures (table 2.b). It seems that governments tend to make use the additional revenue they attain when activity grows to increase public expenditure. However, there is a positive and significant relationship between the cycle and the shadow balance, as an increase in activity leads to less seignorage revenues in terms of GDP.

The results for the financing constraint are robust for both the primary and shadow balance: a tighter financing constraint (increase in interest payments or the implicit interest rate) brings about an improvement in the fiscal position. The correction in the fiscal balance is engineered by an increase in revenues and a decrease in expenditures (although for the interest rate the impact on expenditures is non-significant).[11]

In doing these regressions we have to deal with the issue of endogeneity. We tried to address this issue using instrumental variables technique, but we have too some indication that the casualty runs from left to right in the table (from the interest payments to the fiscal variables), which the sign of the coefficient: if the causality were from fiscal discipline to the financing constraint the expected signs would be the opposite (negative, that is, higher discipline leads to a reduction in the financing constraint).

Finally, it is interesting to explore the link between the cycle and the financing constraint, which is displayed in table 3. For the case of the implicit rate the results are non significant, but we find a strong significant negative relation between the cyclical position and interest payments (although not with the implicit interest rate). As mentioned above, in principle the direction of causality is unclear, and rather it could be thought of a simultaneous occurrence between both facts. To shed a bit more of light on the issue we have perform a Granger causality test, in both directions: the output gap is shown to Granger-cause the interest payments, while the opposite direction of causality is rejected by the test.

[11] When doing these regressions with the whole sample we loose the significance, but not the sign and the relative value of coefficients.

Second stage: exchange rate regimes and the fiscal constraints

Table 4 summarizes how the exchange rate affects the cycle and the costs of borrowing. Recall that the regime is captured by a dummy which takes value of one when the country has a fixed exchange rate. We find a significant negative effect on interest payments and interest rate on debt, but apparently there is no significant correlation between the fixed regime and the cyclical position. Therefore, fixing the exchange rate contributes to relax the financing constraint but it does not generate by itself an expansionary cycle.

Wrap-up of the results

Our hypothesis sustained that the favorable impact of fixing the exchange rates on fiscal discipline through the reduction of seignoriage revenues is offset by the relaxation of the financing constraint and an expansion of activity, which favors an increase in revenues.

Considering together the evidence found so far the reduction of borrowing costs engineered by the peg plays a significant role in determining fiscal discipline: when a country fixes the exchange rate, it enjoys a softer financial constraint, and a softer financial constraint leads to a relaxation of fiscal discipline. Therefore, the first building block of our hypothesis finds strong empirical support.

However, the results are weaker on the cycle channel. We find that expansions tend to have no effect on the primary balance This lack of effect is explained as we find an increase in revenues and in primary expenditures when activity gains momentum. On the contrary the effect is positive on the shadow balance due to the observed reduction in seignorage revenues as a percentage of GDP. Therefore, the direct evidence of the impact of the cycle on fiscal discipline is at best mixed. Notwithstanding this, an indirect impact of the cyclical position is hinted by its effects on the financing constraints, as we find a strong link between the cycle and interest payments and the causality running from the cycle to the financing constraint. So in economic expansions, financing constraint relaxes and through this indirect way, the cycle would has an effect in relaxing fiscal discipline.

But even if this interpretation was valid, fixed regimes have not been found to have a significant impact on the cycle, and this would undermine our proposition. This lack of significance maybe is due to the well known macroeconomic dynamics gener-

ated after the fixing of the exchange rates. Indeed, it is insightful to develop this point in detail.

6. THE DYNAMICS OF THE EXCHANGE RATE PEGS

In this section we focus on the induced dynamics on the relevant economic variables of pegging the exchange rate. There exists a rich literature on the economic implications of exchange rate stabilizations. Exchange-rate-based stabilization schemes (hereafter, ERBS) usually bring about rapid disinflation (due to the anchoring of external prices) and an economic expansion.

From a theoretical perspective, this initial expansion can be explained by inflationary inertia in the service sectors, which, in the aggregate, push down real interest rates (Rodriguez (1982)); or by the imperfect credibility of the new regime which favors present relative to future consumption, inducing a consumption boom in the initial stages of the peg (Vegh (1992)). Moreover, as our results (table 4) show, fixing the exchange rate reduce the borrowing costs, reinforcing these effects. Typically, the expansion is coupled with a growing current account deficit and the appreciation of the real exchange rate. In the medium run, demand exhausts its expansionary impulse and leads to recession and, most of times, to the collapse of the fixed regime. This is a brief account of the characteristic "boom-bust cycle" of ERBS. Econometric evidence on all this aspects is quite robust (Kiguel and Leviatan (1992) and references in Calvo and Vegh (1998)).

This sort of dynamics is central to our hypothesis. Since fixing the exchange rate is the trigger for an expansion which is followed by a slowing down of activity or a recession before the regime is abandoned it is to be expected that the overall effect (which conveys the whole boom and bust cycle) is not significant, as we found in our econometric exercise (table 4).

So it is convenient to explore in detail the behavior of the relevant variables around the peg. The graphical analysis in figure 2, whose charts display the mean and one standard deviation of these variables before and after the fixing (t=1) is an appropriate starting point, but the high volatility of the series makes hard to draw robust conclusions from this visual inspection, so it is useful to complement it with a more formal analysis.[12]

[12] It is important to underline that here we are working with a different sample of that of previous sections. Specifically, we have eliminated fixed regimes

We base the econometric analysis on two different approaches comparing the periods before and after the peg: a cumulative time dummy analysis and a equal coefficient test. The results for selected variables are shown in table 5. The first approach applies time dummies which take a value of 1 in the year in which the peg is adopted (t=1), the year after (t+1) and so on. By sequentially accumulating these dummies and using them as regressors, we can check the effects of the regime shift on the relevant variables. The shaded areas in the graph display the range of periods from the inception of the peg in which the cumulated peg dummy is significant. The second approach defines two dummys representing two periods of time ('before' and 'after' the peg, being 'after' year t, t+1 and so on), and test for the equalization of the coefficients of these dummys. If we find equal coefficients, we can conclude that the behavior of the variable before and after the new exchange rate policy is the same.

The results are as follows:

The disinflationary impact of the peg is evident from the graph (chart a) and it is confirmed by the econometric analysis. For the monetary seignoriage (chart b) visual inspection would suggest a clear reduction, and the parameter associated to the fixed regime is significantly lower. However, the cumulative dummy is only lower for the two first periods (table 5.a).

On the primary balance (chart c) the impact seems to be positive, up to the third year, with cumulated improvements of one and a half of GDP. Beyond that point the improvements reverse and the variable returns to levels previous to the fixing. The econometric tests (table 5.b) only display a marginally significant value for the cumulative dummy between periods t and t+3. The results are more robust for the shadow balance. Now the cumulative increase is around 2% of GDP; although the improvements subsequently reverse, and despite the results for seignoriage just described, the peg turns to improve significantly the shadow balance one year after the peg and for all the following periods, according to the two econometric tests.

Revenues (chart e) dramatically and continuously increase, around 7 percentage points of GDP at t+5, but primary expendi-

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that last more than five years, those countries with no change in their regime in the whole sample, and some observations corresponding to fixed regimes derived from Bretton Woods arrangements. So the results are not fully comparable to those of section 3.

tures (chart f) also increase in parallel. In no case, there is an statistically significant change in the behaviour of the parameters, however (not shown)

The 'boom' phase in the cycle is observable in chart g, lasting until the fourth year after the peg (t+3 in the chart).[13] After that, there is a return to previous levels afterwards, coinciding with the bust phase of the cycle. The two econometric tests (table 5.c) show a significant increase due to the peg after the third and until the fifth year of the peg.

Finally, the impact on borrowing costs (chart h and chart i) strongly supports the softening of the borrowing constraint, since they are consistently and permanently lower under fixed regimes: interest payments shrink around 1,6 percentage points of GDP, and it is particularly relevant the big reduction in the implicit interest rate (7 percentage points). The econometric test supports these results (table 5.d).

To sum up, in the charts it is observed that the improvement on the fiscal accounts exists but tend to be transitory. On the one hand, revenues substantially increase in terms of GDP and then tend to stabilize, but expenditure increases display higher inertia. The improvement in fiscal accounts is probably related to the expansion of activity after the peg and to the reduction of the fiscal burden. When the boom dissipates, revenues and the burden of debt stabilize but expenditures keep on growing, and this is reflected in the worsening of the primary balance. Therefore, fixing the exchange rate trigger dynamics which have perverse effects on fiscal discipline: the deterioration of the fiscal stance at the end of expansion may even be an important explanatory factor behind the final abandonment of the peg, as Kaminsky et al. (1996) show, in their work on exchange rate crises.

7. CONCLUSIONS

This paper has attempted to present and test a comprehensive rationale for the failure of exchange rates to provide fiscal discipline, a result which is statistically robust in our database of emerging countries. Our hypothesis states that fixing the ex-

[13] The chart with raw growth figures (not shown) illustrate a much more drastic change. The point here is that even using a more refine definition of cyclical growth the boom-bust hypothesis holds.

change rate has a negative impact on fiscal discipline through the relaxation of the fiscal constraint of the government. This effect offsets the beneficial impact on discipline that fixed exchange rates should have through the reduction in inflationary financing. In particular fixing the exchange rate reduces the cost and burden of debt and enhances the ability to obtain revenues through a higher level of activity.

The empirical test of these hypothesis has followed a two-stage approach in a panel analysis. The hypothesised channel from exchange rate pegs to lower cost of financing and relaxing of discipline has found a strong empirical support. On the contrary, the second channel, through cyclical expansion and relaxing of discipline is less robust: fixed regimes are not shown to have significant impact on the cycle and the link between economic expansion and fiscal disciplined has revealed blurred.

In order to overcome this problem with the second channel we have explored the evolving dynamics that a peg engineers on the relevant variables and in particular on the cyclical position, an issue on which the literature has focused. The results from this analysis is clarifying and strengthens our hypothesis, since it is shown that at its inception the peg generates an economic expansion, and also softens the financing constraint. The ensuing deterioration of the economic indicators reveals how the peg throws the seeds of its own destruction.

Annex 1

DATA SOURCES AND METHODOLOGIES

This annex presents an overview of the data we have used in the empirical tests. We have selected 32 emerging markets economies and transition countries, of which 18 are from Latin America, other 11 are European transition countries, and the last three are Israel, Russia and Turkey.[14] The selection is made on the basis that for all these countries the choice of exchange rate regime has

[14] Selected countries are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela, Nicaragua, the Dominican Republic, El Salvador, Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Romania, the Slovak Republic, Croatia, and Israel, Russia and Turkey.

played and continues to play a central position in monetary policy strategies.[15]

The bulk of the data are taken from the IMF's 'International Financial Statistics'. They include the official exchange rate, in units of local currency per US dollar (*line ae*), consumer prices (*line 64*), reserve money (line 14), the government deficit or surplus (*line 80*), nominal and real GDP (*lines 99*), public debt (*lines 88 and 89*) and the current account balance (*line 78ald*). Data for interest payments on public debt from the IMF's 'Government Finance Statistics' and from World Bank database are used to construct series of primary deficit. Where it is possible, we have complemented these statistics with national data. In general, we have data from 1972 to 2001 for Latin American countries, Israel and Turkey, and from 1990 to 2001 for European transition countries and Russia.

We define 'seignorage' as the annual change in reserve money scaled by nominal GDP, as in Fischer (1982). It is immediate to see that these calculations are equivalent to the definitions appearing in the text. To compute 'shadow balance' we simply subtract monetary seignorage from primary balance. Consumer price indices are used to calculate the rate of inflation, and the cyclical position is computed as changes in the output gap –relative to GDP, derived from original real GDP series using a Hodrick-Prescott type filter. The lambda used was 100.

We have constructed a separate sample without inflation outliers since they may distort the results. Inflation outliers are defined as those in the last decile of the sample, leaving observations whose inflation rate is less than 120% a year. This leaves a maximum of 598 observations although for some variables, most notably primary deficits, the availability of data is lower.

A more contentious issue we had to deal with was the definition of the exchange rate regimes. Our main source of information

[15] Therefore, we have not included any Asian countries in the sample. It could be argued that we could have incurred in a sample selection bias, but we think that the almost similar economic structure of Latin America and European countries (high presence of the public sector in the economy, high and inefficient bureaucracy, import substitution strategy to develop, etc) and the necessity of stabilizing the economy both type of countries have, in contrast with Asian nations, made the sample homogeneous and help us to avoid the bias. Moreover, we have performed the same sort of analysis using only Latin America countries, and the results, except for the primary expenditure, are very similar to those presented in the paper.

had to be, in principle, IMF's 'Exchange Rate Arrangements And Exchange Restrictions: Annual Report', in which the IMF classified exchange rate arrangements as "Pegged", "Limited flexibility", and "More flexible arrangements". So first of all we construct an 'IMF sample' taking fixed exchange rate regimes as those labeled as "Pegged" according to IMF.

But this definition poses many problems, as it does not include some Exchange Rate Based Stabilizations (ERBS) instrumented via not strictly fixed exchange rates, like crawling pegs or crawling bands, which are labeled as "More flexible arrangements" by the IMF.[16] The IMF itself recognizes this problem in a recent publication (IMF (1999)), and reclassifies many countries' arrangements from year to year. Finally, in 1999 issue of 'Exchange Rate Arrangements…', and in subsequent publications, IMF labels the exchange rate regimes not as fixed or flexible like previously, but as currency boards, crawling pegs, target bands, etc., letting the reader to decide which is a pegged exchange rate an which is not. One of the best examples of the possible inadequacy of IMF's previous definition is the Brazilian *Plano Real,* a "genuine" ERBS dated in July 1994 which was instrumented within a crawling peg system from 1995 to January 1999, and which was labeled as "managed floating" by the IMF.

Having this in mind, we have filtered the IMF sample and constructed an alternative to be used instead of the former. We have added some episodes of semi-fixed exchange rate arrangements that countries implemented with a clear stabilization objective.[17]

[16] Two recent papers, those by Reinhart and Rogoff (2002) and by Levy-Yeati and Sturzenegger (2002) also changes IMF's strict definition. Reinhart and Rogoff distinguish between a "standard" definition of an exchange rate regime, based on IMF's classification, and a "natural" definition, based on the performance of the official exchange rate, declarations from the Government, the behavior of the Central Bank, and so on. More or less, our modified sample coincides with the "natural" classification of Reinhart and Rogoff. Levy-Yeyati and Sturzenegger take five types of exchange rate arrangements, from floating to currency boards, not making any distinction between flexible and fixed regimes.

[17] This is the reason why we consider Brazil'1994 as a ERBS, although it was a crawling peg system, and a Money Based Stabilization Bolivia'1986, a country which currency has been depreciating against the US dollar at a much slower pace than the Brazilian's one. However, in IMF (1999) Bolivia is considered again as a fixed exchange rate, as "the deviations of the market exchange rate from the official exchange rate (…) are extremely tight (…), and that the regime is in practice a crawling peg aimed at maintaining the competitiveness of the economy". Finally, in most recent issues of IMF's International Financial Statis-

Finally, when a country changes its system we have changed its definition if the change occurs in the last six months of the year.

In Table A.1 we show the differences between IMF stricter sample and our sample:

TABLE A.1. DIFFERENCES BETWEEN SAMPLES

Country	*Date*	*IMF sample*	*Modified sample*
Argentina	1979-1980	Flexible	Fixed (*Tablita*)
Argentina	1985-1986	Flexible	Fixed (*Plan Austral*)
Bolivia	1997-1998	Flexible	Fixed
Brazil	1986	Flexible	Fixed (*Cruzado*)
Brazil	1994-1998	Flexible	Fixed (*Plano Real*)
Chile	1978	Flexible	Fixed
Chile	1985-1999	Flexible	Fixed
Colombia	1992-1999	Flexible	Fixed
Ecuador	1995-1999	Flexible	Fixed
Honduras	1997-2001	Flexible	Fixed
México	1988-1994	Flexible	Fixed
Uruguay	1978-1982	Flexible	Fixed (*Tablita*)
Uruguay	1992-2001	Flexible	Fixed
Venezuela	1996-2001	Flexible	Fixed
Hungary	1995-2001	Flexible	Fixed
Latvia	1994-1996	Flexible	Fixed
Poland	1991-1999	Flexible	Fixed

SOURCES: IMF (1999) and own elaboration.

Finally, in table A.2 we show the median of the main variables for the different exchange regimes, once we have filtered IMF's definition:

TABLE A.2. MAIN FEATURES OF THE SAMPLES: MEDIAN

	Without outliers	*Whole sample*
Flexible regimes (observations)	(225)	(276)
Overall balance	-1,76	-2,22
Primary balance	0,33	0,24
Revenues	16,02	16,37
Primary expenditures	15,19	15,67
Total expenditures	18,28	19,58
Inflation	19,75	26,48

———

tics some countries are marked with an asterisk, denoting that "this country has a *de facto* regime which differs from its *de iure* regime". These considerations show that the definition of the regime is not a easy issue. To define theses episodes we have consulted, among others, Kiguel & Liviatan (1992), Tornell & Velasco (1998), Hamann (1999) and IMF (1999).

TABLE A.2 *(continued)*

	Without outliers	*Whole sample*
Monetary seignorage	2,04	2,41
Real GDP growth	3,58	3,38
Interest payments	1,85	1,99
Implicit interest rate	6,38	6,28
Public external debt service	4,27	4,19
Output gap change	0,19	0,03
Shadow primary balance	-1,77	-2,23
Fixed regimes (observations)	(365)	(420)
Overall balance	-2,10	-2,12
Primary balance	0,03	-0,05
Revenues	17,55	17,55
Primary expenditures	18,43	18,18
Total expenditures	20,71	20,56
Inflation	13,05	13,42
Monetary seignorage	1,58	1,71
Real GDP growth	4,32	4,20
Interest payments	1,56	1,49
Implicit interest rate	5,17	5,16
Public external debt service	3,31	3,11
Output gap change	0,93	0,90
Shadow primary balance	-2,05	-2,06

SOURCE: own calculations.

As for the econometric technique, we have used panel data analysis with fixed effects when required (table 2 and table 3). We made the estimations via weighted least squares (WLS) and the heteroskedasticity is corrected with cross sectional variance.

We present the results for the regressions using WLS with a lag of the dependent variable, to take account of persistence in the data (this is equivalent to take a first order autorregresive correction for the residuals).

We also use instrumental variables (IV) to avoid endogeneity problems.[18] The instruments used are first and, in some cases, second lag of the regressor (output gap, implicit interest rate), and lags of the regressor and the current account balance (interest payments). When necessary, estimations are corrected for the presence of first order autocorrelation in the residuals.

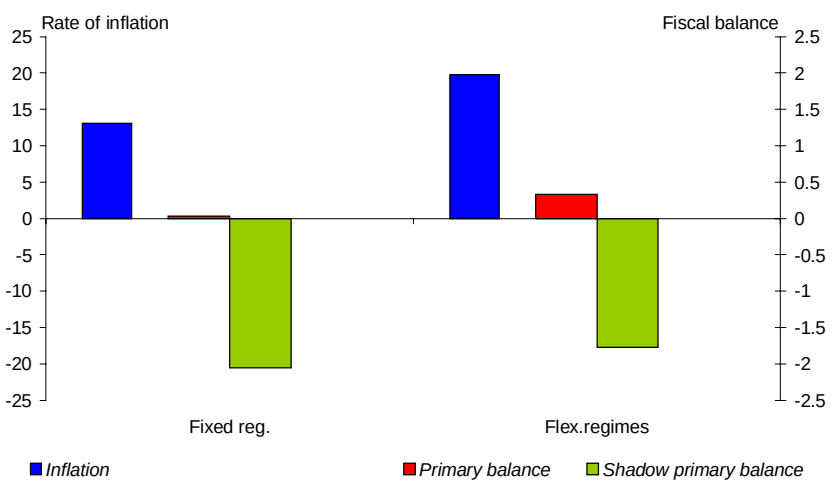
[18] We think that endogeneity is not an issue in tables 1 and 4, as we made the assumption that the exchange rate regime choice is determined independently of the level of the primary balance or the interest payments.

Finally, we have filtered the sample eliminating observations of high inflation, specifically the upper ten percent of the inflation series (change in consumer prices higher than 120% a year). The line 'outliers' in the tables shows changes in the significance of the coefficients when the wider sample is used.

Annex 2

FIGURES AND TABLES CITED IN THE PAPER:

FIGURE 1: EXCHANGE RATE REGIME AND FISCAL DISCIPLINE (a)



Source: own calculations.
(a) Medians of each variable.

Table 1. Exchange rate regime and fiscal variables (a)

	Seignorage	Primary balance	Shadow balance	Accrued revenues	Primary expenditures
Fixed regime	-0,54 (***)	-0,19	0,13	-0,21	-0,03
(t-value)	(-3,93)	(-1,20)	(0,57)	(-1,46)	(-0,20)
Outliers				O (**)	

(a) Estimation via WLS, including first lag of dependent variable in each case.
*, **, *** denote significance at 10%, 5% and 1% respectively.
O in line "outliers" denotes that the estimation usig the whole sample (including outliers) changes the result with the restricted sample to significant
• in line "outliers" denotes that the result shown changes to non significant estimating the relationship with the whole sample (with outliers)

Table 2.a. Combined effects on fiscal variables of cyclical position and financial variables

	Primary balance				Shadow balance			
	WLS (a)	*IV (b)*	*WLS (a)*	*IV (b)*	*WLS (a)*	*IV (b)*	*WLS (a)*	*IV (b)*
Cyclical position	0,02	0,04	0,00	0,04	0,14 (***)	0,19 (***)	0,14 (***)	0,14 (***)
(t-value)	(0,83)	(0,67)	(0,11)	(0,99)	(4,05)	(4,07)	(3,90)	(2,60)
Outliers		O (*)						•
Interest payments	0,27 (***)	0,27 (***)	---	---	0,27 (***)	0,46 (***)	---	---
(t-value)	(5,87)	(3,31)	---	---	(4,02)	(3,80)	---	---
Outliers								
Implicit interest rate	---	---	0,12 (***)	0,12 (**)	---	---	0,13 (***)	0,13 (*)
(t-value)	---	---	(4,54)	(2,12)	---	---	(3,43)	(1,78)
Outliers				•				•

(a) Estimation via WLS, including first lag of dependent variable in each case
(b) Estimation via 2SLS, using first lag of each regressor and the current account balance as instruments.
*, **, *** denote significance at 10%, 5% and 1% respectivley.
O in line "outliers" denotes that the estimation usig the whole sample changes the result to significant
• in line "outliers" denotes that the result shown changes to non significant estimating the relationship with the whole sample

Table 2.b. Combined effects on fiscal variables of cyclical position and financial variables

	Accrued revenues				Primary expenditure			
	WLS (a)	*IV (b)*	*WLS (a)*	*IV (b)*	*WLS (a)*	*IV (b)*	*WLS (a)*	*IV (b)*
Cyclical position	0,06 (***)	0,18 (***)	0,04 (**)	0,18 (**)	0,07 (***)	0,23 (***)	0,07 (**)	0,29 (***)
(t-value)	(2,93)	(2,94)	(2,02)	(2,43)	(2,64)	(3,35)	(2,49)	(3,43)
Outliers	•		•	•	•	•	•	•
Interest payments	0,11 (***)	0,21 (*)	---	---	-0,12 (**)	-0,22 (**)	---	---
(t-value)	(2,68)	(1,92)	---	---	(-2,32)	(-1,99)	---	---
Outliers								
Implicit interest rate	---	---	0,06 (***)	0,14 (*)	---	---	-0,06 (*)	-0,01
(t-value)	---	---	(2,62)	(1,79)	---	---	(-1,93)	(-0,11)
Outliers			•	•				

(a) Estimation via WLS, including first lag of dependent variable in each case
(b) Estimation via 2SLS, using first lag of each regressor and the current account balance as instruments.
*, **, *** denote significance at 10%, 5% and 1% respectivley.
O in line "outliers" denotes that the estimation usig the whole sample changes the result to significant
• in line "outliers" denotes that the result shown changes to non significant estimating the relationship with the whole sample

Table 3. Cyclical position and financial variables

a. Coefficients and significance:

	Interest payments		Implicit interest rate	
	WLS (a)	*IV (b)*	*WLS (a)*	*IV (b)*
Cyclical position	-0,03 (***)	-0,46 (**)	0,03	0,27
(t-value)	(-3,61)	(-2,17)	(1,62)	(0,75)
Outliers				

(a) Estimation via WLS, including first lag of dependent variable in each case.
(b) Estimation via 2SLS, using first lag of cyclical position as instrument.
*, **, *** denote significance at 10%, 5% and 1% respectivley.

b. Granger casualty test (c):

Null Hypothesis	Rejected	F-Statistic	Probability
Output gap does not Granger Cause interest payments	Yes	5,34	0,00
Null Hypothesis	Rejected	F-Statistic	Probability
Interest payments does not Granger Cause output gap	No	0,72	0,58

(c) Test using four lags.

Table 4. Exchange rate regime and factors of discipline (a)

	Interest payments	Implicit interest rate	Cyclical position
Fixed regime	-0,12 (**)	-0,46 (***)	0,37
(t-value)	(-2,41)	(-2,66)	(1,38)
Outliers			

(a) Estimation via WLS, including first lag of dependent variable in each case.
*, **, *** denote significance at 10%, 5% and 1% respectivley.

Table 5.a. Test of structural change (a)

	Monetary seignorage	
	Accumulative (1)	*Equal parameters (2)*
Before vs. t	0,21	Yes
t-value / significance level	0,55	0,330
Before vs. t to t+1	-0,40 (*)	**No**
t-value / significance level	-1,60	**0,001**
Before vs. t to t+2	-0,13	**No**
t-value / significance level	-0,61	**0,004**
Before vs. t to t+3	-0,12	**No**
t-value / significance level	-0,61	**0,003**
Before vs. t to t+4	-0,20	**No**
t-value / significance level	-1,17	**0,000**
Before vs. t to t+5	-0,18	**No**
t-value / significance level	-1,09	**0,001**

Table 5.b Test of structural change (a)

	Primary balance		Shadow balance	
	Accumulative (1)	*Equal parameters (2)*	*Accumulative (1)*	*Equal parameters (2)*
Before vs. t	0,25	Yes	0,39	Yes
t-value / significance level	0,58	0,933	0,61	0,343
Before vs. t to t+1	0,28	Yes	1,08 (**)	**No**
t-value / significance level	1,02	0,942	2,58	**0,011**
Before vs. t to t+2	0,34	Yes	0,77 (**)	**No**
t-value / significance level	1,50	0,954	2,19	**0,032**
Before vs. t to t+3	0,34 (*)	Yes	0,80 (**)	**No**
t-value / significance level	1,65	0,991	2,54	**0,024**
Before vs. t to t+4	0,17	Yes	0,74 (**)	**No**
t-value / significance level	0,88	0,579	2,52	**0,030**
Before vs. t to t+5	0,09	Yes	0,56 (**)	**No**
t-value / significance level	0,49	0,419	1,98	**0,069**

Table 5.c. Test of structural change (a)

	Cyclical position: real gdp growth		Cyclical position: output gap change	
	Accumulative (1)	*Equal parameters (2)*	*Accumulative (1)*	*Equal parameters (2)*
Before vs. t	0,58	Yes	0,70	Yes
t-value / significance level	0,73	0,245	1,00	0,212
Before vs. t to t+1	0,14	Yes	0,54	Yes
t-value / significance level	0,26	0,371	1,12	0,176
Before vs. t to t+2	0,29	Yes	0,74 (*)	**No**
t-value / significance level	0,62	0,225	1,81	**0,068**
Before vs. t to t+3	0,53	**No**	0,84 (**)	**No**
t-value / significance level	1,29	**0,098**	2,34	**0,037**
Before vs. t to t+4	0,21	Yes	0,61 (*)	**No**
t-value / significance level	0,56	0,227	1,84	**0,089**
Before vs. t to t+5	0,14	Yes	0,52	Yes
t-value / significance level	0,38	0,271	1,64	0,122

Table 5.d. Test of structural change (a)

	Interest payments		Implicit interest rate	
	Accumulative (1)	*Equal parameters (2)*	*Accumulative (1)*	*Equal parameters (2)*
Before vs. t	0,18	Yes	0,21	Yes
t-value / significance level	1,28	0,754	0,53	0,340
Before vs. t to t+1	-0,12	**No**	-0,10	**No**
t-value / significance level	-1,31	**0,003**	-0,36	**0,044**
Before vs. t to t+2	-0,14 (*)	**No**	-0,02	**No**
t-value / significance level	-1,78	**0,001**	-0,10	**0,043**
Before vs. t to t+3	-0,17 (**)	**No**	-0,18	**No**
t-value / significance level	-2,46	**0,000**	-0,89	**0,008**
Before vs. t to t+4	-0,18 (**)	**No**	-0,17	**No**
t-value / significance level	-2,86	**0,000**	-0,89	**0,009**
Before vs. t to t+5	-0,14 (**)	**No**	-0,12	**No**
t-value / significance level	-2,36	**0,000**	-0,65	**0,013**

COMMON NOTE FOR TABLES 5.a TO 5.d:

(a) Estimation via WLS, including first lag of dependent variable in each case.

*, **, *** denote significance at 10%, 5% and 1% respectivley.

(1) Accumulative effect of fixing the exchange rate (time t=1) and maintain it two years (t+2), three years (t+3), and so on.

(2) Test of equal parameters in a regression of each variable on two dummys, one representing those years before fixing the exchange rate, and the other the years after the peg. We show significance level (p-value) of the test, accepting the hypothesis of equal coefficients when this p-value is higher than 0,10.

FIGURE 2: EVOLUTION OF SOME VARIABLES AROUND THE PEG (a)

Chart a. Inflation rate

Chart b. Monetary seignorage

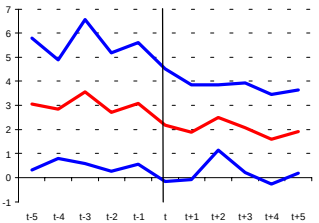


Chart c. Primary balance

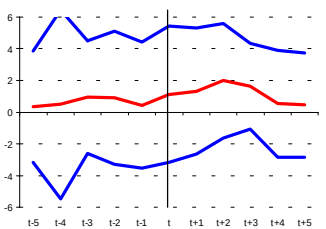


Chart d. Shadow primary balance

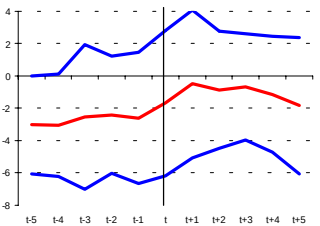


Chart e. Public revenues

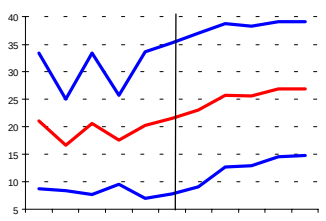


Chart f. Public primary expenditures

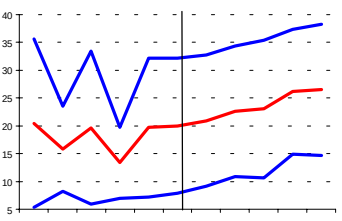


Chart g. Real GDP growth

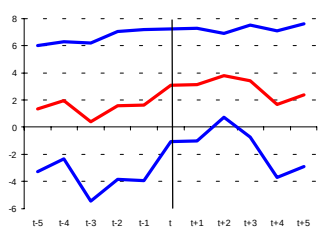


Chart h. Output gap change

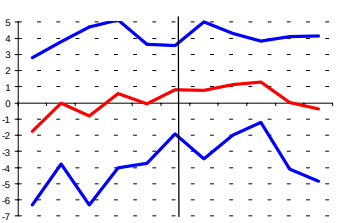


Chart i. Interest payments

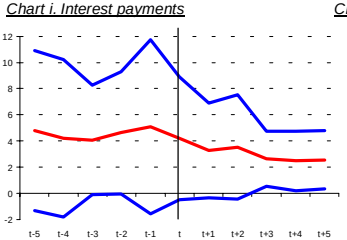
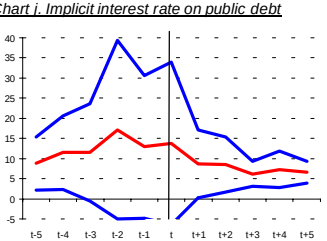


Chart j. Implicit interest rate on public debt



(a) Average value of the variables in the sample, plus and minus one standard deviation

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Gerardo Licandro
José Antonio Licandro

Building the dedollarization agenda: lessons from the Uruguayan case

"I think one has to recognize that there is a social cost to excessive dollarization... I think that what countries have to begin to do is to explore alternative ways of de-dollarizing gradually. Probably the most important kinds of vehicles for doing that have to do with a combination of taxation, information and regulation": Joseph Stiglitz. November 11th 2001, extracted from an interview in Radio El Espectador.

I. INTRODUCTION

Dollarization, since the early 70's has been a topic of special interest for Latin America and Uruguay in particular. However, after a surge in economic literature on currency substitution, where the effectiveness of monetary policy was the issue, the efforts to stabilize inflation relegated dollarization to a secondary role.

Starting with the Asian crisis, balance sheet effects, and dollarization in the case of Latin America have returned to the main stage in policy making. In Uruguay, even though the topic never lost its appeal, the apparently neverending appreciation of the national currency started in the midst of the 80's made the efforts of the advocates of dedollarization fade as the debt ratios plum-

Paper prepared by G. Licandro, economist, Department of Economic Studies, Banco Central del Uruguay and J. A. Licandro, manager, Economic Research Area, Banco Central del Uruguay. *The First English version is dated March 2003. This version is dated September 2003. The opinions contained in this paper are the sole responsibility of the authors and do not compromise the institutions they work for.*

metted. Since then some new spices have been added to the Uruguayan mix. Some were on the right track, as the regulation banning currency mismatches in the balance sheets of banks. Some were bad, as the dollarization of the last defense of long term saving on national currency, namely the *Banco Hipotecario del Uruguay*, the national mortgage bank.

The development of (dollar) credit observed in the second half of the nineties was key to the generalized bankruptcy following the 2002 crisis. Additionally, such risk threatens to become a liability to the taxpayers in an economy in which lobbying of interest groups has resulted traditionally in bail outs by the government.[1]

In this paper we will first survey the characterization the literature has made of this phenomenon –its anantomy– with an aim at pointing out the problems –pathologies– that creates. Then we would try to set up a strategy to reduce the financial fragility derived of non-marketable risks.

The paper proceeds as follows. We start by surveying the literature on dollarization trying to focus on the Uruguayan case. Then we try to sketch some unexplored paths to set up future work. We finish by setting up the basis for a strategy to reduce the financial vulnerability of our economy.

II. URUGUAY AND THE DOLLARIZATION DEBATE

We first study the causes and then the consequences of dollarization. In order to do that in a better way, we will survey the literature and simultaneously introduce the Uruguayan case.

II.1. The causes of dollarization

1) Incomplete Markets

The early literature on dollarization focused on the causes of the phenomena, emphasizing the temporal sequence of events that led to currency substitution.

More recently, Caballero and Krishnamurthy (2000, 2003 a and 2003b) explain credit dollarization as a problem of incom-

[1] As of September 2003, the political system has managed to avoid a legal bail out of debtors in US$. However, political pressure continues to be strong, and has derived in an administrative bail out in public banks.

plete markets at a domestic scale. In countries with financial restrictions national currency denominated external debt would operate as an insurance against real exchange rate shocks. However, when there are financial restrictions, domestic agents would underestimate the risk of borrowing in dollars in order to insure their own financing, generating a negative externality for the economy as a whole.

In Uruguay, the dollarization of assets started as a result of the lack of peso denominated financial alternatives in a chronic inflation country. The process of inflation that started in the 50's deteriorated the confidence of the population in the national currency. At the same time, interest rate ceilings and the lack of inflation indexed assets forced savings out of national currency and into dollar denominated assets. In the mid 50's banks started to take dollar deposits. At first, since foreign currency deposits were not allowed by regulation, banks held dollar deposits as off balance sheet obligations. When the monetary authority allowed dollar deposits in 1962, they started to accept them openly.

In 1969, twenty years after the start of the inflationary process and still under a framework of financial repression, the government created a wage indexed unit of account (UR), in what constituted the first attempt to compete against the dollar (not consciously). Even though the UR was limited to housing savings and to issues of the BHU –*Banco Hipotecario del Uruguay* (public mortgage bank)–, the market of long term papers in UR had a healthy take off, and many Uruguayans saw this unit as an attractive means to save. The stock of UR investment grew steadily until it reached 1,6% of GDP in 1979. Then the BHU, urged by cash-flow problems, defaulted on the adjustment mechanism of OHR (long term UR indexed papers). This default killed the UR market, and the public reliance on the BHU. Not surprisingly, BHU would fail some years later in its attempts to open a CPI indexed market.[2]

With the BHU instruments out of the way, the dollar returned to be the only option for long term savings.

2) Portfolio explanations

Even in economies that developed fair alternatives to the dol-

[2] The CPI instruments of BHU lacked appeal also for two reasons. First, the indexation was monthly (not daily) and the papers had little liquidity. Then, the papers were lagged two months on inflation.

lar, including Chile as the top of the group with its successful experience with the CPI indexed Unidad de Fomento (UF), dollarization had its way whenever there were no explicit bans on dollar denominated assets (as in the case of Brazil).[3] One of the main explanations for this phenomenon is provided by the portfolio approach.

Taylor (1985) adopts this argument to the portfolio choices of households. Ize and Levy-Yeyati (1998) use a portfolio model to explain both the dollarizations of deposits and credit. Calvo and Guidotti (1990) use this approach to explain the dollarization of public debt. Households would demand dollar denominated assets when the correlation of their yield with other assets is negative and the variance of their yield is low. In the case of Uruguay, Licandro and Masoller (1998) have documented the negative correlation between national income and the real exchange rate, meaning that the yield of dollar denominated assets rises when national income falls. This factor shows that, in the case of Uruguay, even if the factors that fostered dollarization would disappear, some dollarization of deposits would remain.

Ize and Levy-Yeyati (1998) extended this argument to the decisions of deposit demand and credit supply of banks. Once more, the stochastic properties of assets and liabilities are the key for the increase on dollarizaton. It has already been pointed out by Pyle (1971) that when the yield of the credit portfolio has a positive correlation with the cost of the deposits, and a positive expected excess return, there are economies of scope on banking this kind of deposits. Furthermore, if there are a negative correlation between national and foreign currency assets, the incentive is even greater. Ize and Levy-Yeyati find that this explanation can only explain partially the levels observed of dollarization. Céspedes, Chang and Velasco (1999) point out that this kind of argument is not able to justify the high levels observed of dollarization.

3) Time Inconsistency and lack of credibility of Monetary Policy

As we stated in point (1), the time inconsistency problem of monetary policy has been one of the factors that contributed the most to the dollarization in Latin American countries. The sys-

[3] In Brazil the demand for dollar denominated assets was canalized through the black market. These resources were held either abroad or outside the formal financial system.

tematic use of monetary surprise as a means of both prompting economic activity and reducing the real value of public debt, eroded the credibility of monetary policy, keeping Latin American countries in the high inflation equilibrium of Kydland and Prescott (1977) and Calvo (1978).

The credibility of exchange rate policies was also depleted by the use and abuse of fixed exchange rate regimes that did not have the fiscal fundamentals to prevent the standard type of crises described by Krugman and Obstfeld. The sharp depreciation of the national currencies with respect to the dollar generated an additional reason to hold dollar denominated assets and stay away from national currency.

Calvo and Guidotti (1990) pointed out that both the indexation and the dollarization of debt are ways to fight disbelief in monetary policy. As the existence of nominal debt on national currency is recognized by the households as an incentive to generate inflation, both the dollarization and the indexation of debt are ways of convincing the public of the commitment of the policymakers to inflation stabilization. This argument is extremely relevant to explain the dollarization of public debt in the case of Uruguay, Argentina and most recently Brazil, and the indexation of debt in the case of Chile. Fifty years ago, most debt was issued at a fixed rate in national currency. As inflation reduced the credibility of monetary policy, the cost of public debt issued in national currency skyrocketed. Additionally, most of these countries implemented stabilization plans in the early nineties characterized for the use of the exchange rate as a nominal anchor. Obliged to issue debt to face its obligations, the Governments were forced or tented to consider the use of "cheaper" sources of financing: indexed instruments.[4]

4) Warranties and Risk Miscalculation

Caballero y Krishnamurthy (2000) formalize the idea that, in equilibrium, when there are incomplete markets, agents tend to miscalculate the macroeconomic effect of their microeconomic decisions. According to this authors, a private contract can internalize the currency mismatch risk embedded in the balance

[4] These sources seem to be cheaper in terms of interest rates, but what is gained in cash flows, is lost in strength. The dollarization of public debt increases the fragility of public accounts, as the recent crisis in Latin America, namely, Argentina and Uruguay have shown.

sheets of the parts of the contract, but cannot internalize the systemic consequences of a generalized process of dollarization. Burnside, Eichembaum y Rebelo (2000), on the other hand, show that the existence of warranties on the financial system, despite having expansionary effects in the short time, incentives the risk taking behavior of the private sector and, therefore, results in excessive exchange rate positions. As the government covers the risk, it is not priced in the interest rate, and foreign currency credit is perceived as "cheap". A broad interpretation of this idea would categorize a fixed exchange rate system as a warranty. The private sector internalizes the future exchange rate path and this gives further incentives to the dollarization of credit. In Uruguay this argument is appealing both on the sense that we have had different kind of warranties on the financial system and because fixed exchange rate regimes have been a constant of our economic history.

Warranties, in Uruguay in particular, have been part of a misdesigned Safety Net. One of them is the Implicit Deposit Insurance scheme. Such scheme, supported by the Government, makes dollar-denominated deposits and loans cheaper for banks and depositors respectively both because, there were no limits for the insurance and the insurance itself was free (Bergara and Licandro 2000). Another important historical reference is the tradition of generalized bail outs for debtors through "administrative" decisions on public banks or compulsive refinancing on private banks by law.[5] In this way, all agents involved in this moral hazard cocktail are completely insured by the State. More so since the regulation of the banking sector does not incorporate the obligation of banks of having more capital if they are going to take on dollar credit to the non tradable sector. Broda and Levy-Yeyati (2003) call this prudential regulatory mistake as "currency-blindness" of regulation.

II.2. Consequences of dollarization

1) Credit dollarization and financial fragility

The financial crisis of Argentina and Uruguay in 2001 and 2002 reinforced the arguments for regulation punishing currency mismatches. Prudential regulation in several countries, particularly in Uruguay, recognized this need only partially after the

[5] After the 82 debt crisis, three laws were passed to "restructure" the debts of the private sector.

1982 debt crisis, attacking the mismatch on the balance sheets of banks. However, since the same considerations did not apply to the credits of the banks, exchange rate risk remained disguised as credit risk. When bank debtors have a currency mismatch, large swings in the real exchange rate will generate large capital variations in the portfolio of the bank.

The existence of implicit warranties, as argued in the previous section, reduces the incentives of the banking sector to recognize the risks involved in lending in dollars to sectors that have their income in national currency. Then, that risk is not priced and it is not incorporated in the interest rates charged in the credits to those sectors, further incentivating the dollarization of credit. In equilibrium, the share of this kind of assets in the portfolio of the banks is larger than what would be socially optimum.

Other aspect of the emerging countries financial fragility is linked to the role of lender of last resort. Recently, Broda and Levy-Yeyati (2003) suggest that the cost of the lender of last resort is larger in the case of foreign currency than in the case of national currency. National Central Banks cannot issue dollars, but they can issue national currency. The recent experience of Uruguay and Argentina supports this view.[6] Therefore, similar liquidity requirements in both cases are implicit subsidies to the dollarization of the portfolios of banks. Therefore, the authors suggest that both liquidity requirements and the cost of deposit insurance should be higher for foreign currency deposits. Regulatory provisions preventing the deepening of dollarization were also suggested by the IMF on their document on Monetary Policy on dollarized economies.[7]

2) Dollarization and fiscal policy

In financially open chronic inflation countries, the evergrowing

[6] In both cases a banking panic and a run on public debt formed part of a vicious cycle in which the deterioration of the sustainability of fiscal accounts worsened the panic on the banking sector, which in turn worsened the sustainability of fiscal accounts. In the case of Uruguay, this perverse spiral was worsened by the implicit warranty of the government on the banking sector. Furthermore, in the Uruguayan case, deposits in domestic currency in public banks were not rescheduled.

[7] The IMF concerns were more on the side of finding effective tools to reduce dollarization to improve a country's ability to manage monetary policy. Despite lacking a general equilibrium back up, their recommendations are pretty much on line with what has been suggested by the literature later on.

distrust on fixed interest rate bonds on national currency made it prohibitively costly to issue that kind of debt. When Uruguay made its first serious attempts to control inflation this problem became evident, leading to the dollarization of public debt. Uruguayan public debt was fully dollarized by the mid 70's. When Uruguay had to abandon the "tablita" in November 1982, its debt to GDP ratio almost doubled, reaching unsustainable digits. This happened despite the Uruguayan government kept until 1981 what most analysts, including the IMF, considered as a solid fiscal stance. Besides, the effect of the relative price adjustment on the credit portfolio of banks led to the generalized insolvency of the payment system, causing the bankruptcy of several banking institutions whose bad credits ended up being bought by the government (Vaz (1999)).

Licandro (2000) shows that with a dollarized debt, public finance systems characterized by stability in an interval like the Uruguayan, small variations in the real exchange rate can move public finances, out of the stable interval and into a divergent path.

Tragically, the same kind of threshold effect operated in the 2002 crisis. Uruguay still held an investment grade rating by the main three rating agencies early in 2002.[8] However, the sudden change created by the regional crisis in the expected long run real exchange rate implied a very large adjustment. With the new equilibrium relative prices the finances of the government fell outside the stable interval (if there were any) damaging the perception of sustainability of public debt. At the same time, the banking sector started to experience a serious run on the deposit base that depleted more than 40 % of that market, liquidifying the international reserves of the Central Bank. On the one hand, the reserve evaporation occurs because the Central Bank should act as a Lender of Last Resort in a dollarized framework. On the other hand, such evaporation was related with public warranties mentioned before and materialized in governmental assistance to the banks in trouble. International reserves were also depleted because the Government was not able to roll over debt. The public started to feel that the implicit warranty of the government did not have value and that the backup of the government was disappearing, speeding up the run on the deposits of the banks. The

[8] The Investment Grade for the Uruguayan sovereign debt was confered in the first half of the 1997 by Stantadard & Poor's, Moody's and today's merged Duft & Phelps and Fitch-IBCA.

run, further accelerated by the sudden change of the exchange rate following the decision to allow the exchange rate to float on June 2002, determined the closure of activities of five banking institutions. As in the 80's, depositors, despite having to cope with some of the costs of the banking bankruptcy, were partially, and in some cases completely, bailed out by the government with the support of the IMF.

The example of the Uruguayan crises give us a powerful example of the kind of financial fragility that dollarization poses on the public finances. On the one hand, the relative price adjustment has a direct impact on the government's balance sheet, increasing the cost of debt. In fact, the negative correlation between activity and real exchange rate causes a procyclical effect in the burden of interest payments, pushing up fiscal deficit in recessions. Simultaneously, the relative price adjustment raises the debt to GDP ratio, affecting debt sustainability. On the other hand, the crisis triggers the activation of potential liabilities of the government, which were not previously accounted for. To further worsen the situation, the relative price adjustment is accompanied by a large-scale recession that shrinks tax revenues. To manage this holocaust without incurring in the default of the public debt requires a large fiscal adjustment or generous external financing.[9]

3) Dollarization and exchange rate regime

After a large period in which this topic did not seem to matter, the late 90's witnessed a surge in the literature on this issue. In the 80's and early 90's the focus was in the role which dollarization could play on the choice of nominal anchor in an inflation stabilization program. In this literature, highly dollarized economies, therefore with a high degree of indexation to that currency, would find it more suitable to fix the exchange rate to bring down inflation. Besides the efficacy of the anchor, it has been pointed out that stabilization programs anchored on the exchange rate are accompanied by an initial boom of consumption, in opposition to monetary anchors that generated an early bust (Kiguel and Liviatan (1992) and Végh (1992).[10] Then, a fixed ex-

[9] Uruguay had to restructure public debt in 2003 despite reducing real expenditures by 13.8% and receiving a large support from the IMF.

[10] Among the reasons given to that initial boom stand out: lack of credibility in the program, wealth effects, nominal rigidities, etc.

change rate program would tend to have more political support than a monetary one.

More recently, the academic discussion concentrated on the role of dollarization on the optimal choice of long run exhange rate systems. The main question is To Fix or to Float?

Calvo and Reinhardt (2000) pointed out that countries in the emerging world have "fear of floating". According to this authors countries that claim to float have extremely large International Reserves, and the exchange rate behaves as if it were controlled by the Central Bank. Indeed, they point out that the volatility of the interest rates in countries like Mexico, Colombia, Perú, among others, exhibit a larger volatility of Central Bank interest rates than in the exchange rate, a typical outcome under a fix but not under a float.[11, 12]

The question is then whether a dollarized country should fix or float. Calvo (1999), using Pool's optimal exchange rate system line of reasoning, argues that dollarization not only reduces money demand increasing the volatility of the LM curve as it was argued in the 70's, but also has a direct effect over the IS curve. He argues that a radical change on the relative prices drags firms into insolvency, restricting investment and production. This way, the IS could have a negative slope on the nominal exchange rate, and would be much more volatile. If the aim is to minimize the volatility of output, the existence of a very volatile IS would point out to the need of a fixed exchange rate system, much more so under a negative sloped IS that would magnify the volatility of the IS curve.

Céspedes, Chang and Velasco (1999, 2000 and 2001) and Bernanke, Gailchrist and Gertler (2002) have pointed out that balance sheet effects are not enough to justify the fixing of the exchange rate when the volatility of the relative prices is low. According to this series of papers, and using a general equilibrium framework with balance sheet effects inspired in Bernanke and Gertler (1991), if an economy is perturbed outside the steady state by a external shock, the trade effect of the exchange rate adjustment would overpower the balance sheet effect. Despite the undeniable elegance of their analysis, the kind of shocks they work with do not resemble the earthquakes emerging countries

[11] Levy-Yeyati and Sturzenegger (1999) use cluster analysis to determine whether countries fix or float

[12] More recently, Schmidt-Hebbel and Werner (2002) argue that countries like Mexico, Colombia and Chile have grown out of "fear of floating".

have to go through, and could not resemble them because they work with linearized steady state dynamics. Furthermore, even though the model allows the default of the individuals on banks, i.e.credit risk, it does not incorporate the possibility of massive bankruptcy of the banking sector as it was the case in Uruguay and Argentina in 1982 and 2001-2002. . Finally, the comparison they make between fix and float does not rule out the possibility that an intermediate form of adjustment would perform better. Calvo and Mishkin (2003) argue that floating might not be the right answer at any point since timing and institutions matter.The recent Uruguayan experience is a good example of their point. On june 2002, Uruguay faced both a run on public debt and a panic on the banking sector.[13] However, there were no run on the currency yet. The country was loosing international reserves fast, but not a penny on the exchange rate market. The approximately US$ 1.3 billion of international reserve assets held by the Central Bank of Uruguay on June 18th, the day prior to the float, were clearly insuficcient to back up US$ 10. billion of deposits or US$ 4.0 of debt service in the next two years, but were at least three times the monetary base and more than two times the monetary aggregate M2. Then, the country let go the only commitment that could be sustained in the short run. By doing so without solving the two basic challenges the economy was facing, it worsened the panic on the banking sector and, eventually, the run on public debt. Both effects were foreseable. The float made clear that the credit portfolio of the banks, and therefore their capital position were weakened suddenly. Furthermore, the evident generalized bankruptcy problem made very likely a bail out scenary, prompting the lobbying reaction of pressure groups. Even though the adjustment of the exchange rate was unavoidable, the timing of the decision was clearly wrong.

If we add up all that has been said, and the accumulated experience in dollarized countries like Uruguay and Argentina, even though exchange rate flexibility to adjust permanent shocks is key, the case for some form of exchange rate management remains strong for dollarized economies.

4) Dollarization and monetary policy

Dollarization affects monetary policy mainly through the re-

[13] See Licandro (2003) for a discussion on the decision to float on the uruguayan 2002 crisis.

duction and increased volatility of the demand for money (currency substitution). Berg and Borenztein (2000) enphasize those aspects and claim that in dollarized economies the relevant monetary aggregates are not the traditional national currency aggregates. Since saving and transactions are performed in foreign currency, the traditional transmission of monetary policy would not work properly if countries would concentrate on traditional aggregates: to have the same kind of control one should work with aggregates that include assets in dollars. However, as the authors point out, the Central Bank has no control over dollar assets.

Céspedes, Chang and Velasco (2001), argue that a *flexible inflation targeting* with a mixed use of interest rates and exhange rates could be more effective than a fixed exchange rate. However, to date there is no comparison between a controlled devaluation like the one that a target zone or a crawling peg system would obtain, with the float on impact. Moreover, the proposal of Céspedes et al. (2001) and others like Moron and Winkelried's non-linear monetary scheme for Perú, could be restated using the exchange rate as an instrument. Licandro (2001), considering the Uruguayan case, argues that an interest rate partial reaction rule could be substituted by a controlled devaluation system, with no commitment to the exchange rate, with endogenous interest rates.

5) Dollarization and Financial Fragility in the Pension System

Uruguay changed its pension system in 1995. It was added to the old pay-as-you-go system a complementary, but increasingly important, system based on personal savings. The new scheme includes privately-administrated pension funds by specialized firms (the *Administradoras de Fondos Previsionales* –AFAP's). Workers save along their active life in those funds, and when retirement time comes, they are required to buy a *life annuity* from an insurance company. This kind of pension system works like a relay race. The first part of the race is run by the AFAP, which manages the saving's portfolio of the worker. The second stage of the race is run by the insurance company, which receives the portfolio from the AFAP and pays the pension. When the financial system is dollarized, not only the banking system, also AFAP's portfolio includes naturally dollar-denominated assets, which should be transferred to insurance companies when a worker retires. However, the insurance companies' liabilities are in pesos

indexed to a wage indexed unit known as UR (unidad reajustable) by law, because the Legislator tried to maintain the real value of the pension through this indexation mechanism. The outcome is a currency mismatch in the insurance companies balance sheet and then, a financial fragility issue in the pension system as a whole. The pension system's fragility works exactly in the opposite direction as the banking system's fragility. As we pointed out in part (a), the insolvency problem on the banking system occurs when the real exchange rate depreciates. The insolvency problem in the pension system would occur when the real exchange rate appreciates.

In the Uruguayan case, the described financial fragility of the pension system is not a problem today but it is a real threat for the medium and long run. In the same way as the bail outs in the financial system, a generalized bankruptcy in insurance companies would likely result in a liability for the State, mainly because it would generate a huge social problem that would require governmental assistance. Then, the financial fragility in the pension system adds a new and strong argument for the design of a dedollarization strategy.

III. A SIMPLIFIED EXPOSITION OF THE CASCADING OF BALANCE SHEET EFFECTS IN A DOLLARIZED ECONOMY

As we mentioned before, the literature on dollarization is rapidly growing. Nevertheless, there is some milage left to cover to be able to make a fair representation of the depth of the phenomena in, at least, three strands:

i) The potential for banking default.

ii) The fiscal impact, both on public debt and potential liabilities.

iii) The long run impact. When a banking crisis occurs, a legacy of property rights battles reduces the incentives to investment and damages the ability of countries to grow.

In this section we will try to stage the first two effects as the first step in a research program on dollarization. In that sense, we will try to show how the cascading of balance sheet effects due to dollarization emerge, starting with the firms up to the triggering of potential liabilities to the government through the banking crisis.

III. 1. The balance of the firms.

We will use the net present value (NPV) of a firm as an indicator of its value, as Fernández-Arias and Talvi (2000). If the firm sells non tradable goods and has dollar liabilities, and assuming for simplicity that the project last only one period, the NPV can be expressed as:

$$NPV = \frac{y - qD}{1 + r} \tag{1}$$

Where y, the production of the firm, is produced and sold at the end of the period, q is the relationship between the nominal exchange rate (e) and the price of the non tradable good (p) that will prevail at the end of the period (, we will loosely call it real exchange rate). r is a real discount rate in national currency and D stands for debt service. Debt is acquired at the beginning of the period and paid for at the end of the period.

If the NPV of the firm is positive, the firm is considered solvent from an economic standpoint.

The NPV of this firm depends negatively on the real exhange rate q. Indeed, every increment of q reduces the NPV proportionally to the partial derivative ($\frac{\partial NPV}{\partial q} = -\frac{D}{1 + r}$). If there were a change in relative prices strong enough, an initially solvent firm can easily be forced to default on its debt obligations.

Then, a firm that operates on the non tradable sector, with dollar liabilities, whose prices are linked to the conditions of the domestic market, are naturally vulnerable to real exchange rate depreciation.

Such vulnerability hinges exclusively on the fact that this firm was not able to contract its debt in national currency. If this firm were to finance itself in domestic currency, its NPV would look like in the next equation:

$$NPV = \frac{y - D}{1 + r} \tag{1'}$$

It is also the case that if the firm is an exporter, the future value of the real exchange rate does not affect the viability of its project. The NPV of such a firm would look like:

$$NPV = q\frac{y - D}{1 + r} \tag{1''}$$

III. 2. The vulnerability of banks

Lets assume that a bank receives dollar deposits at the beginning of the first period (d_0), pays for them an interest rate i_p and then returns them at the end of the period. The bank gives credit in the same currency (C_0) at an interest rate i_a to an agent that has a project on the non tradable sector. We would assume that the bank is only subject to a minimum capital requirement and a currency mismatch ban. In this case, the balance sheet of the bank can be represented as follows:

$$d_0 + k_0 = C_0 \tag{2}$$

Since both its credits and deposits are dollar denominated, the bank has no currency mismatch on its balance sheet. However, this does not mean that the exchange currency risk has disappeared, it has "evolved" into credit risk. Then, the debtor of the bank, is the one that is directly exposed to the mismatch of currencies in its balance sheet as represented in (1).

To describe the kind of vulnerability that the bank faces, it is convenient to look at its residual value. The residual value can be expressed as the difference between the residual value of the credit portfolio plus the capital of the bank less the deposits and the accrued interest.

$$VB = \text{Recovers} - d_0(1 + i_p) - k_0 \tag{3}$$

The residual value of the credit portfolio depends on the ability of the bank's debtors to repay, asymmetric information issues aside, the debt. We have seen in (1) that this ability depends on the level of q at the end of the period. We can find two relevant thresholds in the residual value of the bank.

a) There is a level of q that we would call q^1 below which the debtors of the bank have no problems repaying their debts. In this case the bank can earn the interests of the credit portfolio without pains and the residual value of the bank would look as follows.

$$VB = C_0(1 + i_a) - d_0(1 + i_p) - k_0 i_a \quad \text{if } q \le q^1 \tag{4}$$

b) When the real exchange rate goes above q^1 more and more debtors of the bank start to have problems to repay. We will assume that those debtors are subject to a standard debt contract, and that the bank can appropriate without costs the residual

value of the business from then on. In that case, the residual value of the bank would start to decline smoothly. At first the yield of the rest of the credit portfolio would be enough to generate still some benefits. As q grows, it would eventually reach a point in which the credit portfolio would generate losses that the bank would have to cover with its own cap ital.

(4') $$VB = \frac{y}{q} - d_0(1+i_p) - k_0 \quad \text{if } q > q^1$$

Eventually, q would reach a value where the capital of the bank would not be enough to cover the losses of the loan portfolio, i.e. the bank becomes insolvent. The story from then on depends on the institutional setting of the Safety Net.

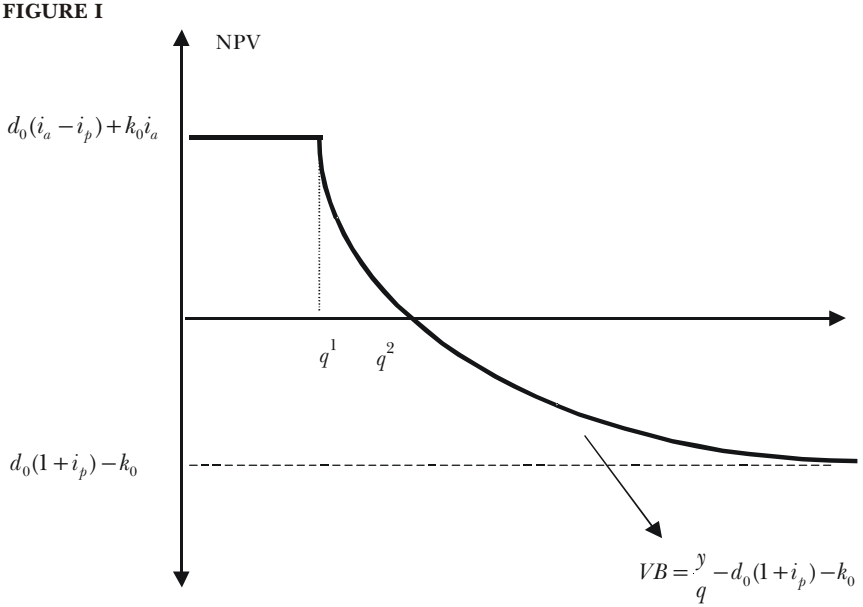
If there is no institutional solution for this outcome, depositors would be the ones to bear the losses.

If a deposit insurance scheme exists, depositors and the deposit insurance institution would share the losses as agreed.

If there is no deposit insurance, but an implicit warranty by the government exists on deposits, the losses of the bank become a liability of the public sector.

We can plot a simplified picture of this financial sistema as follows:

FIGURE I



III. 3. The impact on the fiscal side. Government as the ultra non-tradable agent

Assuming that the government pays its expenditures (g) and collects its tax revenues (t) in local currency, and that government debt is denominated in foreign currency (D_g) paying an interest rate i_g, its balance sheet looks pretty similar to equation (1). The financial fragility of the government is worsened by the potential liability that might arise in the financial system, as a result of the existence of an implicit deposit insurance scheme for the banking system. Then, the State, should a large relative prices shock occur, might become insolvent, in the same fashion as the private sector. Licandro, G. (2000) shows that a dynamic system of public debt like the one we depict in this section has two steady states, one stable and one unstable, meaning that public debt is only sustainable in an interval. Therefore, fiscal shocks, like sudden changes in relative prices, can drive the public finances into a divergent path.

$$(5) \qquad rf = (g-\tau) + q(i_g Dg) \qquad \text{if } q<q^2$$

$$rf = (g-\tau) + q(i_g Dg) + \left\{q\left\lfloor d_0(1+i_p) - k_0 \right\rfloor - y\right\} \qquad \text{if } q>q^2$$

The equation above represents the balance sheet of the government. The first term is the primary result. Financial vulnerability is introduced in the second term: the interest bill. The third term, which appears when $q>q_2$, represents the potential liability arising from the implicit deposit insurance scheme.

As a result, it can be fairly said that the government is the most fragile of the dollarized-non tradables: this is because it not only bears its own mismatch risk, but also the one of the sectors that have grounds for a bail out.

IV. A STRATEGY TO COMBAT THE FINANCIAL VULNERABILITY CAUSED BY DOLLARIZATION[14]

In the previous sections we have analyzed the anatomy of dollarization, and its main pathology: financial vulnerability. As it is the case in every pathology once it has been identified, the next question is: Is there anything we can do to combat this pathology?

To answer this question we first need to determine how far

[14] This section draws heavily on Licandro and Licandro (2003).

should we go in this fight. Should we fight it at all? Some scholars have argued that, since these countries are already highly dollarized, they should go all the way and completely dollarize their economies (See Calvo (2000) and Paniza, Stein and Talvi (2003)). However, even in a dollarized economy a non-tradable sector would exist (at least a government), and the risk of a large adjustment in relative prices would remain, much more so in a region like Mercosur. Then, full dollarization does not reduce the financial vulnerability of the economy on impact, and the long run effects depend on the ability of the country to develop trade with the US. This ability would vary from country to country, but, in the case of Uruguay, it is impaired by the fact that Uruguay is a natural partner (in Krugman's sense) of Mercosur. Therefore, a unilateral dollarization by Uruguay does not seem a good alternative in a region as unstable as Mercosur: some exchange rate flexibility is needed, as it was the case in the Real and the 2002 crises.

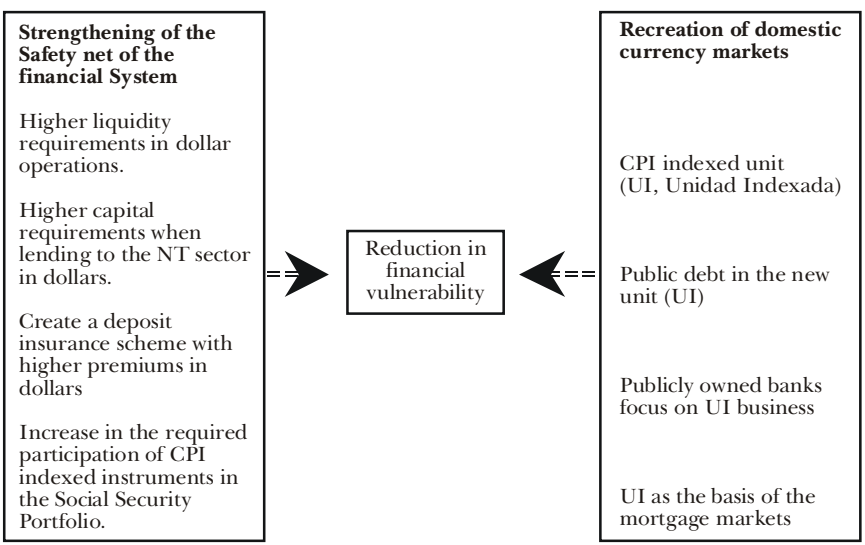
Full dedollarization is not the answer either. The same financial matching principle driving our concerns about the State and the non-tradable sector would apply to the tradable sector if we were to forbid foreign currency operations in the financial system.

Acknowledging that neither full dollarization or full dedollarization are the solution, the question is: how can we live in the middle? What can we do to reduce financial vulnerability? An obvious answer is that agents should have the chance and the incentives to hedge the risks involved in their portfolio. To do that it is necessary to develop an strategy based on two pillars.

i) *Strengthening of the Safety Net of the financial system*. Financial regulation in several countries does not fully incorporate the risks involved in the dollarization of their business. That was particularly clear in the cases of Argentina and Uruguay in 2002, but it is also true for several other countries. It is necessary to rethink this situation that undoubtedly has favored dollarization. Prudential requirements have to be stricter when the financial system lends to an agent that perceives its income in domestic currency, even more soif that agent is the State itself. Liquidity requirements have to be higher in dollar business, reflecting the inability of Central Banks to perform the lender of last resort in foreign currencies. The recognition of those risks will likely give us a smaller financial system , but a healthier one.

ii) Recreation of domestic currency asset markets. It is necessary to have a domestic unit of account that can be the basis of a future credit system. With nominal domestic currency markets long lost to past misconduct, a new alternative is needed. In this sense, the experience of Chile with the UF appears as a benchmark to study, and a path to explore. Uruguay and Argentina are moving in that direction, with the issue of CPI indexed debt. However, to obtain a viable alternative to the dollar, creating a new unit of account will not suffice: The government will have to step up and have a proactive position to develop CPI indexed markets.

The following scheme shows how a strategy like the one depicted in the previous paragraphs should start in the case of Uruguay.



IV. 1. Recreation of domestic currency markets: the case of Uruguay

The ellimination of the commitment to the exchange rate is a valuable first step. Under a floating exchange rate regime the real yield of dollar assets is more volatile, incentivating the use of other inflation hedging instruments like the UI. In the future, even though it is not clear either the possibility nor the desirability that Uruguay could manage a pure float, the commitment of

macroeconomic policy should lie on inflation stability rather than on the exchange rate. Other reforms that would surely benefit the development of the financial system in general, and markets in domestic currency in particular relate to macroeconomic stability: central bank independence and fiscal sustainability.

The second logical step in the recreation of markets in a domestic currency is to develop a unit of account that the public could trust. In a future stained by inflationary uncertainty, the obvious candidate to take on that role is a CPI indexed unit. Uruguay created the UI in July 2002. This unit is a copycat of the Unidad de Fomento in Chile, and it is quoted daily.

During 2002 the Uruguayan government took the first steps in the creation of a yield curve on UI denominated assets by issuing the first series of UI indexed government bonds. This has created the opportunity for the first private issues of UI assets by the private sector. However, there is still plenty to do in order to generate a viable alternative to the US dollar.

First, the government has to continue with its policy of issuing UI indexed bonds, both to ensure a reference yield in the new unit of account and to reduce its own financial vulnerability. A long-term preanounced calendar of debt issuance will contribute to reassure the public of the Government resolve, further deepening the market.

Then, the financial system should start allowing UI deposits. In Uruguay, the government has an opportunity to make a decisive move in this direction by using the market power that the State owned Banco de la República (BROU) has in domestic currency markets. BROU, with a nearly 40% share of domestic currency markets, both credit and deposits, has traditionally played the role of the leader of this segment. Then, if BROU embraces the UI business, it is highly likely that the rest of the system would follow.

The government has already made use of its leadership by switching Banco Hipotecario's financial activities to UI. It is early to assess the result of this move that was already proposed by Licandro and Licandro (2001), but, as the system develops, it should give a push to UI markets. Traditionally, saving deposits in BHU have been big part of the domestic currency portfolio of residents. Until 2001 the mortgage system hinged on the UR and the US dollar as the indexing units. The switch, to be made on the marginal deposits and credits, is both a sign of coherence on the long run monetary choices of the State, and a direct move towards the development of UI markets.

IV. 2. Strengthening of the Safety net of the financial System: the case of Uruguay

Regulation has to incentive both the financial system and the pension system recognition of the risks involved in currency mismatches. We have shown that the regulation has been unable to do that at several levels:

i) Solvency regulation, both capital requirements and provisions, do not penalize lending to non-tradable sectors in foreign currencies, even though their risk is higher.

ii) Liquidity requirements not only did not penalize dollarization, but, in some cases they even encouraged intermediation in dollars. In Uruguay, until 2002, while short term deposits in pesos had a reserve requirement of 30%, dollar deposits only had 10%.

iii) The deposit insurance scheme not always incentives banks to account for risks properly. In the Uruguayan case, until 2002 the market behaved as if there were a complete and free (implicit) deposit insurance scheme. After the financial crises of 2002, the fiscal situation has made clear that no further assistance from the State can be expected.

All these defects need to be addressed in the regulation. Both solvency and liquidity requirements have to be made up to avoid inducing financial vulnerability, even more so after the recognition of the inability and impropriety of the government to fully back up deposits. On the liquidity side, a differential requirement between pesos and dollar denominated deposits is advisable. On the solvency side, capital requirements and provisions should be higher for dollar denominated credit to non-tradable sectors than in the credit with no currency mismatch. Also, a deposit insurance scheme should be created. This scheme should take into account the risk of currency mismatches into the premiums charged to banks (as suggested by Broda and Levy-Yeyati (2003)).

In the short run, this kind of regulatory measures reduces the vulnerability of the financial system even in the case dollarization should not be reduced significantly. Indeed, even in the case UI credit would not boom, the financial system would be stronger, reducing the chances of both a systemic and fiscal crisis. First, because there will be a more capitalized and liquid banks. Second, because there will be a better Safety Net.

It is highly likely that credit in dollars would be more expensive than it was in the past, but a healthier financial system should improve the country's growth path. A more expensive credit is the logical result of regulatory recognition of risks. However, in the long run the overall cost and effectiveness of the credit activity should be better for several reasons. For starters, a fairly priced risk should provide a better incentive for resource allocation. A healthier financial system would reduce the chance of systemic crises, avoiding all the political economy issues related to property rights that arise in those episodes. In every financial holocaust like the ones experienced by Uruguay and Argentina in the debt crisis and 2002, societies fight to determine who should bear the burden of the shock. Somewhere along the way, as it has been widely documented, institutions fall, change and even disappear. The institutional change brings about institutional uncertainty and hampers the confidence of private agents on the economy, with a long run effect on private investment and growth.

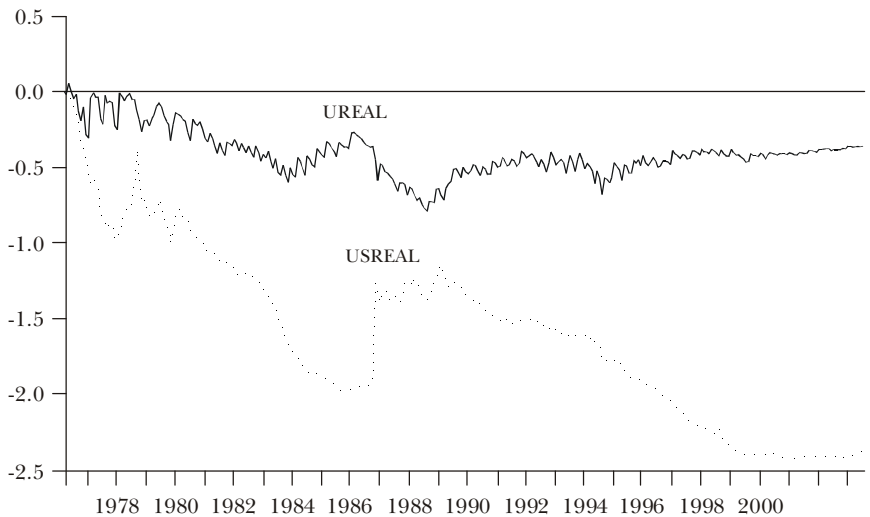
The same strategy should be oriented to reduce the financial vulnerability in the new pension system, as it was mentioned in section II.5. Regulation on the pension system should aim to minmize the currency mismatch in the system's portfolio. To achieve that it would be necessary that both, assets and liabilities of the system were denominated in the same unit: the UI. Why the UI and not the UR as the Uruguayan Constitution instructs? First because social security savings are aimed at ensuring future consumption and the UI is the only unit of account that actually gives a fair reference in that sense. Secondly, the UR's yield is positively correlated with income, meaning that nobody would want to save in that currency in the long run. Prove of that is that the UR has existed for more than twenty years and, it has never been used other than for housing financing in public banks. Then, it is almost impossible that a viable domestic-currency alternative to the US dollar could emerge other than the UI.

Some people have argued, regarding the constitutional indexation of the Uruguayan social security system to the UR, that saving in UI also involves a mismatch for the system for as long as the constitution is not changed in that respect. And they are right in an obvious sense. However, the kind of risk a dollar portfolio poses on the system, as shown by the graph below, is much larger than a portfolio based on UI assets.

In order to mitigate the mismatch of the Uruguayan pension system some legal and regulatory changes need to be made. First, it would be convenient to switch the reference of the system from

the UR to the UI. This issue can become potentially difficult since some law experts affirm that a constitutional amendment is necessary. Even if first is not possible, the Regulator should determine the limits to dollar investments in the system's portfolio, nowadays managed by the AFAP's.

FIGURE II. URUGUAY: REAL VOLATILITY OF WAGES AND THE US DOLLAR



As a by-product, if the country takes this kind of measures in the pension system it is probable that the dynamism and growth needed by the peso-denominated markets would be provided by the pension funds. In this sense, the different regulatory agencies: the bank regulator, the pension founds regulator, the insurance companies regulator and the stock market regulator -all included in the Central Bank of Uruguay-, should work together in a unified and consistent regulatory strategy.

In the end, we want to emphasize two important points. First of all, the exposed strategy and agenda are preliminary and should be deepened and perfected in order to achieve the sought reduction in financial vulnerability. We are convinced that a successful strategy involves the unified efforts of several battlefronts, oriented to both incentive the development of domestic currency markets and strenghten the safety net of the financial system.. Second, the strategy presented herein does not try to (neither could) eliminate the presence of the dollar in the economy, endeavour that we see as neither desirable nor convenient in the

normal workings of an economy in which the two pillars of our strategy are working properly.

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Federal Reserve System (United States)

Other Institutions

Superintendencia de Bancos y Entidades Financieras (Bolivia)
Superintendencia de Bancos (Dominican Republic)
Superintendencia de Bancos y Seguros (Ecuador)
Superintendencia del Sistema Financiero (El Salvador)
Comisión Nacional de Bancos y Seguros (Honduras)
Superintendencia de Bancos (Panama)
Banco Centroamericano de Integración Económica
Banco Latinoamericano de Exportaciones, S. A.
Fondo Latinoamericano de Reservas