

Uruguay: Selected Issues

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URUGUAY

Selected Issues

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OVERVIEW

Dollarization was at the center of Uruguay's last crisis, and the next six chapters shed light on its implications for monetary and exchange rate policies, and for financial vulnerability. Questions tackled by these studies include: Is there scope for monetary policy in Uruguay, given that it remains one of the most dollarized economies in the world? What drives inflation and expectations in the economy? Does enhanced monetary policy credibility reduce dollarization, thus helping increase the effectiveness of monetary policy? What is the exchange rate pass-through to domestic prices and the effectiveness of a flexible exchange rate as a shock absorber? Is Uruguay now less vulnerable to financial spillovers and global and regional shocks? How do banks' balance sheets affect the transmission of domestic and external shocks? What is the implication of dollarization for the optimal level of reserves? How vulnerable are banks' balance sheets and how do they compare to the pre-crisis period?

The papers find that, despite dollarization, there is scope for monetary policy, but also a need to further reduce vulnerabilities. The central bank has gained credibility in leading inflation expectations; the pass through is partial and declining; there is a limited but growing credit channel. The financial system has strengthened and is now less vulnerable than before the crisis. That said, external developments play a major role in determining domestic conditions, including through sovereign spreads and bank lending in foreign currency. Moreover, Uruguay is still seen by investors as more prone to global and regional shocks than before the crisis. Thus, it is key to sustain sound policies and further reduce vulnerabilities to advance toward regaining the investment grade lost in 2002.

The first essay explores the dynamics of inflation focusing on the role of inflation expectations and its determinants in the dollarized system. Making use of survey data, the study finds that inflation expectations are more important than lagged inflation in shaping the inflation process, suggesting that inflation inertia is relatively small. The results also indicate that fiscal variables are important in explaining expectations and that the central bank has been gaining credibility, with announced inflation targets playing an increasing role in forming expectations.

The second paper assesses the recent evolution of the exchange rate pass-through to prices and the scope for reducing dollarization through monetary policy credibility. In line with developments in other emerging markets, the paper finds that the pass-through in Uruguay has declined over the years. However, the results also suggest that it has become volatile and unstable since late 2005, when the authorities moved away from the free float adopted in the aftermath of the 2002 crisis. Also, consistent with experience in other countries, it finds that monetary policy credibility affects financial dollarization, although long periods of time may be needed for credibility to deliver its benefits.

The third essay examines market perceptions of vulnerability and, specifically, the determinants of Uruguayan sovereign spreads. It concludes that, while fundamentals explain part of the variation in sovereign spreads, external factors play a key role and have become more important since the 2002 financial crisis. While Uruguay was largely insulated from regional and EME shocks until the crisis, Uruguayan spreads have since moved closely with those of neighboring countries. Econometric estimates suggest that investors

perceptions of Uruguay's financial interdependences were revised significantly following the crisis. The results point to heightened financial spillovers and vulnerabilities to global and regional shocks, following the downgrading of Uruguay to speculative grade. Thus, despite Uruguay's recent credit rating upgrades, it is key to maintain appropriate policies to continue making strides toward regaining investment grade status.

The fourth paper uses micro-level data to draw inferences about bank behavior. It finds evidence of a bank lending channel in local currency. A monetary contraction (expansion) reduces (expands) credit; in line with the hypothesis on financial frictions, the effect is stronger for less liquid and less capitalized banks. This mechanism is still quantitatively limited given the preponderance of foreign-currency lending, but is growing. There is also evidence of a similar transmission of foreign shocks, with less capitalized and liquid banks adjusting lending in foreign currency more strongly to changes in U.S. interest rates. As lending picks up and bank liquidity levels decline, the banking system will further amplify domestic and foreign shocks. Competitive conditions are then assessed, with a view to gain insights into Uruguay's low financial intermediation compared with developed countries. The paper finds relatively low competition compared to other countries.

The fifth essay assesses the adequacy of foreign reserves as insurance against balance of payments and banking crises. Incorporating explicitly the dollarization of bank deposits, the paper models the optimal level of reserves as one that balances the consumption-smoothing benefits and the quasi-fiscal costs of holding reserves. The results indicate that reserves are nearing optimal levels, given the sharply improved debt profile away from short term, reduced nonresident deposits, and substantial liquidity held by banks. Nonetheless, further reserve accumulation is desirable going forward. As the recovery matures and lending picks up, banks' liquidity would decline and higher reserves would be needed from a prudential perspective. Moreover, higher levels would also be useful for crisis prevention, beyond the crisis mitigation objective taken into account in the framework.

The final paper examines vulnerabilities of the banking system from the perspective of balance sheet exposures and asset volatility. After updating the 2006 FSAP stress tests, it adapts the contingent claims approach to examine banking sector's vulnerabilities, using monthly balance-sheet data of individual banks. The study shows a substantial improvement in the estimated default probability since the 2002 crisis. Stress tests also show that, while important vulnerabilities remain, banks resilience to shocks has further increased since the 2006 FSAP was conducted.

I. THE INFLATION PROCESS IN URUGUAY

By Gaston Gelos and Fernanda Rossi Iriondo

A. Introduction

1. *Following chronic high inflation, Uruguay reduced inflation gradually through a disinflation program in the 1990s, reaching single digits by 1998.* Inflation has since remained moderate, except for an outburst during 2002 financial crisis and devaluation. In that year, the country moved to a flexible exchange-rate regime and inflation began declining quickly to low single digits by 2005. It has since increased somewhat to around 6–8 percent.

2. *With relatively high inflation vis-à-vis the region and other emerging markets, a relevant question is how costly it would be to reduce it further.* Various aspects of the factors driving inflation in Uruguay remain to be understood better. First, what is the degree of inflation persistence and to what extent is inflation driven by backward-looking behavior and expectations? Understanding this is important for the conduct of monetary policy—with high backward-looking behavior, temporary inflationary shocks tend to persist and the output costs of reducing inflation quickly are higher. Second, what are the determinants of inflation expectations? This question is relevant given the monetary authorities' increased focus on the inflation objective, de-emphasizing monetary targets. In such a context, anchoring expectations is a precondition for a successful monetary policy.

3. *This paper explores the dynamics of inflation in Uruguay, making use of survey data, focusing on the role of inflation expectations and their determinants.* First, it assesses the role of inflation expectations in shaping the inflation process by estimating a New-Keynesian Phillips curve. Second, it explores the determinants of survey expectations. Third, it discusses the rationality of survey expectations.

4. *The paper finds that expectations are more important than lagged inflation in shaping the inflation process, suggesting that inertia is relatively small.* The importance of lagged inflation decreased with the adoption of a flexible exchange rate and has remained low since then. The results also suggest that, in addition to marginal cost proxies, fiscal variables are important in explaining expectations. There is some evidence that the central bank has gained credibility, with announced inflation targets playing an increasing role in forming expectations. Survey expectations over a 12-month horizon are neither unbiased nor efficient, but 1-month-ahead inflation expectations appear to be rational.

B. Inflation Dynamics and Inflation Expectations

5. *To assess the importance of inflation expectations, a structural price-setting model is used nesting two types of price-setting behavior* (see Gali and Gertler, 1999, Celasun, Gelos, and Prati, 2004a,b, and Celasun and McGettigan, 2005). Backward-looking price setters update the average new price based on the most recently observed inflation rate. Forward-looking price setters set prices based on their expectations, which may or not be rational. The resulting inflation rate in period t equals:

$$(1) \pi_t = \alpha + \delta\pi_{t-1} + (1 - \delta)E_t\pi_{t+1} + \phi mc_t + \varepsilon_t$$

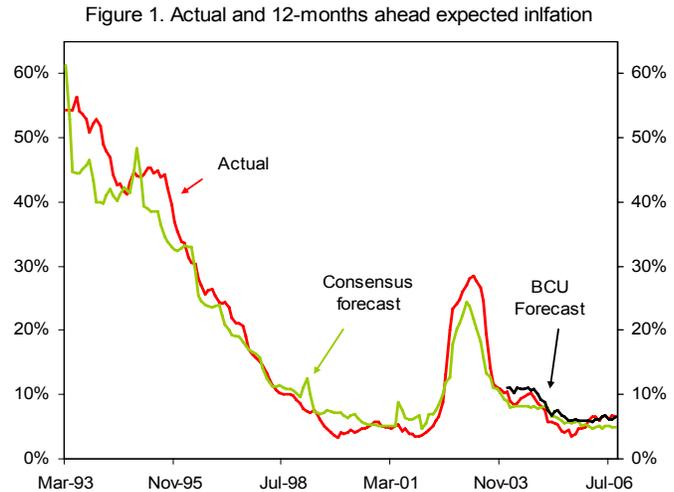
where π is the 12-month (or monthly) CPI inflation rate, $E_t\pi_{t+1}$ is the expected inflation rate in 12 (or 1) month(s), π_{t-1} refers to inflation between 24 and 12 months ago (or between 2 and 1 months ago), and mc are marginal costs.

6. In the empirical work, annual inflation expectations from consensus forecasts is used.

For comparison purposes, a shorter sample of monthly inflation expectations from a survey conducted since 2004 by the Uruguayan Central Bank is also used (Figure 1).^{1,2}

Since a typical firm in a small open economy is likely to use imported intermediate goods and domestic labor as inputs in production, a combination of the real effective exchange rate and domestic real unit labor costs (both in deviations from a linear trend) is used as

a proxy of real marginal costs. Data for the period 1998:01–2006:09 is used. To address potential endogeneity problems, the equation is estimated by GMM. The equation is also estimated on a monthly forecast horizon for inflation forecasts for 2004:01–2006:09 from a Central Bank of Uruguay survey.³



7. The results indicate that inflation expectations drive the inflation process (Table 1). In the case of annual inflation, the coefficient on expected future inflation is close to one, while the coefficient on lagged inflation is insignificant in all but one case, where it is slightly negative. The real effective exchange rate enters the estimation with a statistically significant positive coefficient, in line with the notion that foreign prices are important in determining prices in Uruguay. Using monthly data, the role of expectations is even stronger. The coefficient on expected future inflation is larger than one, while the coefficient on lagged inflation is negative and smaller. Proxy marginal costs enter the estimation significantly with positive coefficients, but a much smaller fraction of the monthly variation in inflation can be explained compared to the case of annual data. Table 1 shows estimations with the

¹ One year-ahead inflation expectations are calculated as a weighted average of this and next year's inflation forecast. Data are available on a monthly basis starting in 2001 and bimonthly prior to that. Data is interpolated for the missing months.

² Roberts (1995) and Roberts (1997) pioneered the use of survey expectations in estimating Phillips curves and inflation dynamics in the U.S. Use in emerging markets is not widespread.

³ The monthly survey conducted by the Central Bank is available since 2004.

coefficients on lagged and expected inflation constrained to sum one, as suggested by theory. The key results do not change when estimating the equations without restrictions.

Table 1. CPI Inflation Regressions with Survey Data

Forecast horizon	One year				One month			
Estimate	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.003 (0.003)	0.003 (0.004)	0.002 (0.007)	-0.031 (0.075)	0.001 (0.001)	-0.002 (0.002)	-0.001 (0.001)	-0.004 (0.008)
Lagged inflation	-0.17 (0.106)	-0.08* (0.045)	-0.032 (0.134)	-0.168 (0.227)	-0.18 (0.161)	-0.30* (0.162)	-.28* (0.143)	-0.28 (0.168)
Inflation forecast	1.17*** (0.106)	1.08*** (0.045)	1.032*** (0.134)	1.168*** (0.227)	1.18*** (0.161)	1.30*** (0.162)	1.28*** (0.143)	1.28*** (0.168)
Real effective exchange rate gap	13.9*** (2.905)	0.879 (7.934)	-	-	-	6.12*** (2.936)	-	-
Real wage gap	-	-0.002* (0.001)	-	-	0.000 (0.000)	0.001*** (0.000)	-	-
Output gap	-	-	-0.116** (0.051)	-	-	-	-0.013 (0.008)	-
Unemployment rate	-	-	-	0.262 (0.552)	-	-	-	0.028 (0.070)
Adjusted R ²	0.92	0.92	0.86	0.85	0.27	0.45	0.40	0.40
Sample	1998:01-2006:09				2004:01-2006:09			
Number of Observations	105				33			
Source of Inflationary expectations	Consensus Forecasts				Central Bank of Uruguay			

Notes: GMM estimates. Andrews bandwidth standard errors are given in parentheses. For 12-months forecast horizon the instruments for lagged inflation were inflation(-2) in equations 1 and 4; 12-month exchange rate change(-2) in equation 3 and lagged inflation in equation 2. Oil prices inflation(-1) was used as instrument for inflation forecast. The other regressors were used as instruments in the remaining equations. For 1-month forecast horizon, the equation 1 includes inflation forecast (-1) as instrument for inflation forecast. The other regressors were used as instruments in this and the remaining equations.

*, **, *** indicate significance at the 10, 5 and 1 percent level, respectively.

8. ***Estimations allowing for the possibility of nonstationarity confirm the key results.*** With relatively short time series, the issue of possible nonstationarity is difficult to address given the low power of standard tests. Tests following Clemente, Montañés, and Reyes (1998) suggest the presence of a unit root even after allowing for two structural breaks (not shown). Thus, we also estimate a system using the FIML (full-information maximum-likelihood) method by Johansen and Swensen (1999), confirming a stationary relation between inflation, expected inflation and proxy variables of marginal costs. In line with the GMM results, the estimated coefficient on expected inflation was above one and significant. The proxies for marginal costs were positive but not statistically significant (not shown).

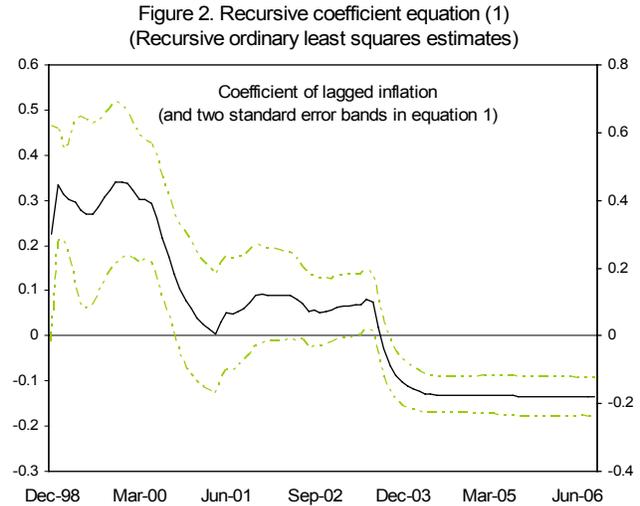
Recursive estimates

9. *A recursive estimation shows that the importance of lagged inflation has declined.* Indeed, it falls sharply after the floating of the exchange rate, stabilizing after mid-2003 (Figure 2).

Inflation persistence

10. *The role of lagged inflation is limited, even after accounting for its impact on expectations and wage formation.* If inflation expectations were largely driven by past inflation, the coefficient on lagged inflation would underestimate the overall role of past inflation in shaping the inflation

process. To explore this issue, equation (1) is re-estimated, replacing expected inflation by the residual of a regression of expected inflation on lagged inflation, finding that the coefficient does not change substantially. Similarly, backward-looking wage indexation may induce inertia through the marginal cost variable, thus leading to underestimate the importance of lagged inflation. Therefore, the residuals of a regression of unit labor costs on lagged inflation as marginal cost proxy are also used, without altering the qualitative results. All these factors point to low inflation inertia.



C. Determinants of Inflation Expectations

11. *What are the factors explaining inflation expectations?* Since inflation expectations appear to be a key driving force of Uruguayan inflation dynamics, anchoring expectations is important for monetary policy. Following Celasun, Gelos, and Prati (2004), it is key to investigate the role of past inflation, fiscal outcomes, the exchange rate, monetary policy variables, and real wages on inflation expectations by estimating variants of the following general model:

$$(2) \pi_t^e = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 pb_{t-1} + \alpha_3 mc_{t-1} + \alpha_4 \text{monetary variables}_{t-1} + u_t$$

Where pb_{t-1} is the ratio of the consolidated primary fiscal balance to GDP and the monetary variables include year-on-year M1 growth or alternatively exchange rate change (see Licandro and Vicente (2006), for a discussion of the link between fiscal policy and inflation objectives in Uruguay). It is also important to examine whether there has been a structural break in the post-crisis expectations formation using a dummy variable. Equation (2) is estimated by a generalized method of moments in order to address potential endogeneity problems, using both 12-months and 1-month-ahead horizons.

12. *The results suggest that lagged inflation, the primary balance, and marginal costs proxies explain expected inflation (Table 2 and Figure 3).*

Monetary aggregates only become important after the adoption of a flexible exchange rate regime and do not play a role in shorter horizon forecasts. Changes in the nominal exchange rate affect expectations, but the effect is modest and not significant for 1-month-ahead expectations. Lagged inflation contributes 50–60 percent to explaining expected inflation; although for 1-month expectations the contribution is significantly smaller. For the 12-month ahead estimation, recursive coefficient estimates on lagged inflation stabilize around 0.6 after the adoption of a flexible exchange rate in 2002 (Figure 4).

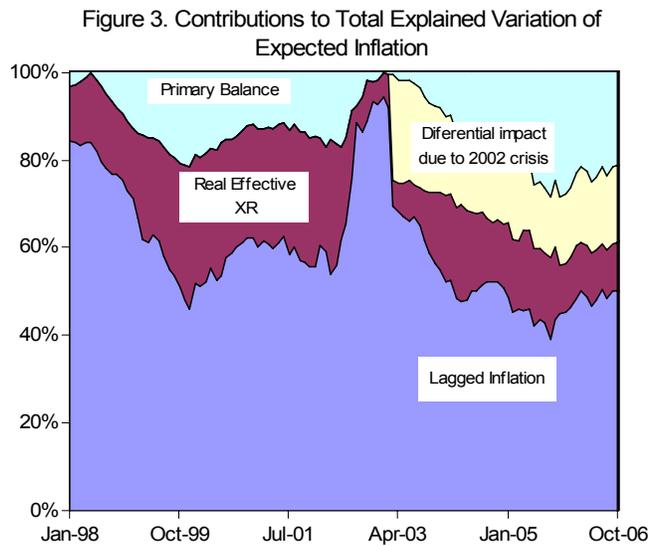


Figure 4. Determinants of Inflationary Expectations: recursive coefficients
(Recursive ordinary least squares estimates on an annual horizon)

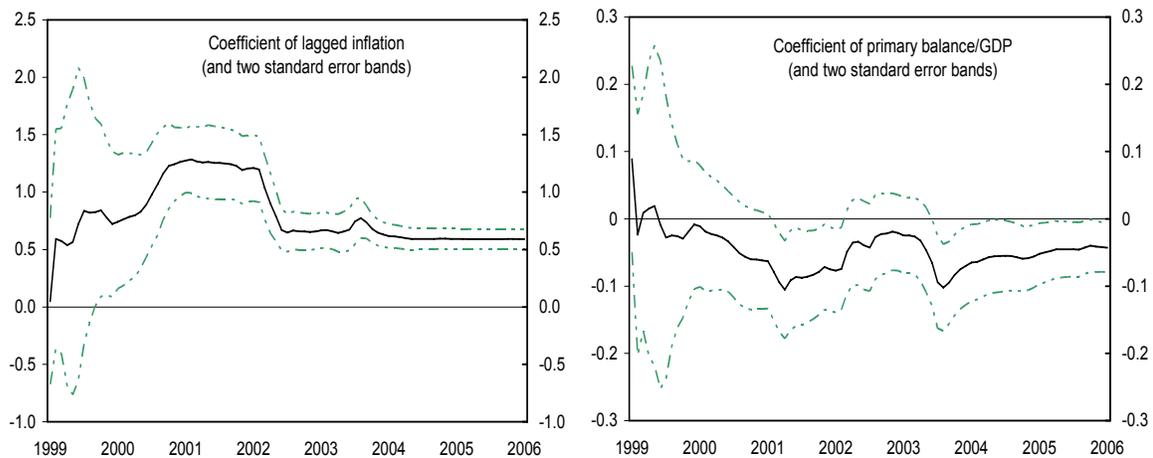


Table 2. Determinants of Inflation Expectations

Estimate	GMM estimates							C.E.
	-1	-2	-3	-4	-5	-6	-7	
Constant	0.039***	0.042***	0.001	-	-0.11***	0.010***	-	0.03
Inflation (-1)	-0.004	-0.004	-0.026	-	-0.039	-0.003	-	n.a.
Inflation Target(-1)	0.699***	0.662***	0.76***	0.76***	-0.064	0.240**	0.243**	0.8
Primary balance/GDP(-1)	-0.03	-0.029	-0.075	-0.067	-0.133	-0.108	-0.0943	-0.086
Real effective exchange rate gap (-1)	-	-	-	-	1.44***	-	-	-
Real wage gap (-1)	-	-	-	-	-0.489	-	-	-
Unemployment rate (-1)	-0.005***	-0.005***	-0.003**	-0.003**	0.018***	-0.001**	0.001***	-0.012
Year-on-year M1 growth (-1)	-0.001	-0.001	-0.002	-0.0015	-0.005	-0.001	0	-0.003
Year-on-year exchange rate change(-1)	12.96***	-	-	-	32.69***	1.510**	1.550**	60.02
DC	-3.32	-	-	-	-7.532	-0.659	-0.649	-16.72
DP*Inflation(-1)	-	-0.002***	-	-	-	-	-	0.005
Adjusted R ²	0	0	0	0	0	0	0	-0.002
Forecasts horizon	-	-	0.19	0.20***	-	-	-	-
Sample	-	-	-0.203	-0.039	-	-	-	-
Number of Observations	-	-	0.05	0.05	-	-	-	-
Source of Inflationary expectations	-	-	-0.04*	-0.04*	-	-	-	-
	-	-	-0.022	-0.02	-	-	-	-
	-	-	0.02*	0.02**	-	-	-	-
	-	-	-0.015	-0.011	-	-	-	-
	-0.243***	-0.216***	-0.18**	-0.18***	-	-	-	-
	-0.035	-0.026	-0.078	-0.037	-	-	-	-
	0.93	0.94	0.88	0.92	0.84	0.26	0.16	0.24
Forecasts horizon		12-month ahead			12-months ahead	1-month ahead	12-months ahead	
Sample		1998:01-2006:10			2004:01-2006:10	2004:01-2006:10	1998:01-2006:10	
Number of Observations		106			34	34	106	
Source of Inflationary expectations		Consensus Forecasts			Central Bank of Uruguay	Central Bank of Uruguay	Consensus Forecasts	

Notes for GMM estimates: Andrews bandwidth standard errors are given in parenthesis. Instruments include inflation(-2), inflation(-3), primary balance/GDP(-3), real wage gap(-2), real wage gap(-3), money growth rate (-2), money growth rate(-3), DC and DP. Estimate (5) and (6) excludes DC and DP as instruments, where DC and DP are dummy variables capturing two different effects of 2002 crisis. DC=1 in 2002:07-2003:2 period, thus it captures a transitory increase of inflationary expectations due to the crisis. DP=1 from 2003:3 onwards, thereby it captures some structural changes after the crisis. The estimation results showed that only lagged inflation coefficients have experienced a structural change due to the 2002 crisis.

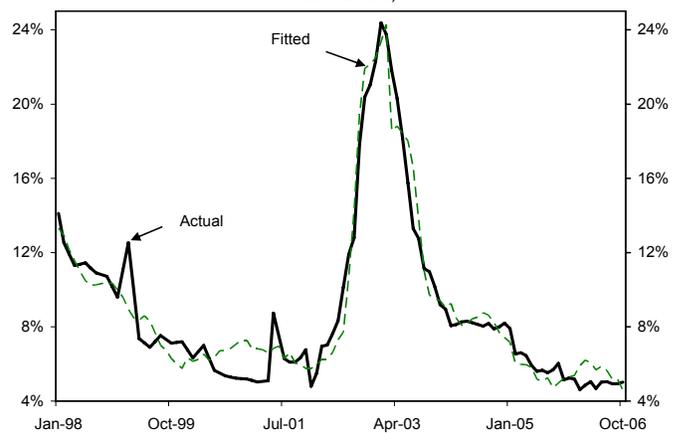
*, **, *** indicate significance at the 10, 5 and 1 percent level, respectively.

Notes for C.E. (Cointegration Equation) estimates: standard errors are given in parenthesis.

13. *The primary balance plays a role in determining expected inflation.*

It enters with a negative coefficient in almost all the estimated equations (see Celasun, Gelos, and Prati, 2004 a,b, and Cerisola and Gelos, forthcoming) and, for estimations with a 12-months ahead horizon, the coefficient increased slightly since 2003. The quantitative significance of this factor is, however, moderate: a one percent increase in the primary balance as a percent of GDP is estimated to yield a fall in inflation expectations by about 0.5 percentage points. For a shorter forecast horizon, it is also significant but less important. The model tracks inflation expectations quite well, including during the crisis period (Figure 5).

Figure 5. 12-months ahead Expected Inflation: Actual Versus Fitted (GMM-based Model)



Source: Author's calculations.

14. ***There is some evidence that announced inflation targets have gained credibility.***

Inference is limited given that the paper works with data starting January 2004, using the mid-point of the 12-month-ahead inflation target range. The coefficient on the inflation target is significant, and on lagged inflation insignificant. Recursive (OLS) estimates show that the coefficient has been approaching one during 2006 (Figure 6). These results suggest that forecasters are forward-looking and increasingly anchoring expectations around the central bank targets.¹ The notion of a recent increase in central bank's credibility is consistent with the evolution of the dispersion of inflation forecasts. In particular, the coefficient of variation for survey expectations show no clear trend until early 2006 and a decline since then (Figure 7). However, this result needs to be taken with caution. As discussed in the next chapter (López-Mejía, Rebucci, and Saizar (2007), announced targets for inflation and indicative ceilings for M1, combined with intervention in the foreign exchange market partly to resist nominal appreciation, have created ambiguity about the objectives and instruments of monetary policy, thus undermining monetary policy credibility.

Figure 6. Recursive Estimates of Coefficient on Inflation Target (Recursive OLS estimate)

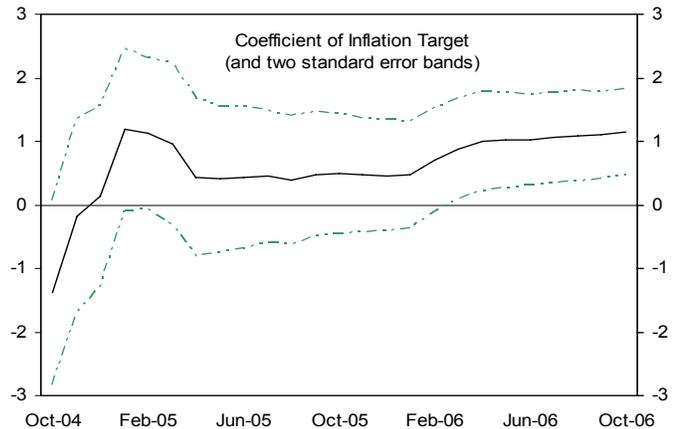
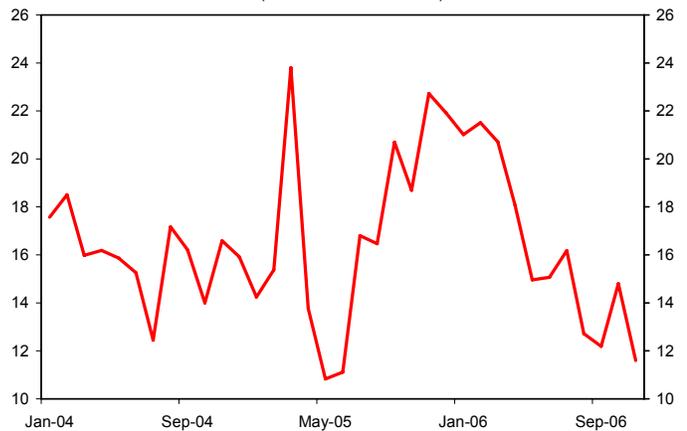


Figure 7. The Dispersion of Inflation Forecasts (coefficient of variation)



15. ***Estimations taking into account possible nonstationarity reinforce the results.*** A Johansen cointegration test finds a stable relationship between expected inflation, lagged inflation, primary balance, real effective exchange rate, and real wage gap; a vector error correction model suggests that the 12-months ahead inflation forecasts are determined by lagged inflation, primary balance and the marginal costs proxies. The estimated coefficients have the same signs and only slightly higher magnitudes than the GMM estimates.

¹ See Cerisola and Gelos (forthcoming) and Minella (2003) for similar results on the relevance of inflation targets for the case of Brazil.

Rationality

16. *Are expectations rational?* To explore this issue, the paper first examines unbiasedness, regressing actual inflation on both an intercept and expected inflation:

$$(3) \quad \Pi_t = c + \beta \Pi_t^e + \varepsilon_t$$

If expectations are unbiased, c should be zero and β one. This is the joint hypothesis tested in the paper (Table 3).

Table 3. Tests of Unbiasedness of Inflation Forecasts

Coefficients	Consensus forecasts	Central bank of Uruguay
α	-0.031	-0.004
β	1.35	1.46
Adjusted R2	0.89	0.382948
Coefficient (p-values)	Consensus forecasts	Central bank of Uruguay
$\alpha = 0$	0.0001	0.0520
$\beta = 1$	0.0001	0.0816
$\alpha = 0$ and $\beta = 1$	0.0003	0.1265
Sample period	1998:01-2006:09	2004:01-2006:09

17. *The central bank of Uruguay inflation forecasts appear unbiased for 1-month ahead, but biased for 12-month ahead.* However, the tests should be interpreted with caution given the potential nonstationarity of the series. Generally, the estimated coefficient of an I(1) variable is not normally distributed, invalidating the usual tests. In any case, however, the paper would reject unbiasedness for the 12-month ahead inflation expectations.^{2,3}

18. *Allowing for the possibility of nonstationarity, the results confirm that expectations do not use all available information.* Johansen (1991, 1995) tests find a cointegration relation between actual and expected inflation (Appendix Table A1). The speed at which expectations are revised over time in light of new information is estimated through a bivariate VEC model with inflation and expected inflation (Appendix Table A2). If the parameter on the expectation error in this regression is significant, then consumers revise their expectations and adjust them toward the fully rational outcome. The estimated coefficients are negative and significant for both the 12-months ahead and 1-month ahead forecasts, implying low persistence in deviation between actual and expected inflation. However, regressions of the forecast errors on different variables indicate that 12-month-

² See similar results for other Latin American countries in Carvalho and Bugarin (2006).

³ The results are not an artifact from the approximation for the 12-month forecasts as unbiasedness is also rejected for much shorter subperiods.

ahead forecasts fail to extract all possible information from all the relevant variables,⁴ except for past information on the real effective exchange rate gap. On the other hand, 1-month ahead forecasts seem efficient in the use of past information, except for the informational content of actual inflation (Appendix Table A3).

D. Conclusions

19. ***This paper examined the role of inflation expectations in shaping inflation dynamics, the degree of inflation persistence, and the rationality and factors driving inflation expectations.*** The key results are:

- Inflation expectations are more important than past inflation in shaping the inflation process. As a result, inflation inertia is not high. However, recent changes in wage agreement mechanisms containing backward-looking elements may lead to an increase in inertia.
- Moreover, the role of lagged inflation in shaping the inflation process has been declining since 2002.
- Confirming previous studies' results, fiscal variables play a role in driving inflation expectations, with a higher primary balance associated with lower expected inflation.
- The evidence suggests that the central bank has gained credibility since the adoption of a flexible exchange rate and the announcement of inflation targets. Forecasters increasingly take the central bank's targets into account when forming expectations.
- 12-month-ahead inflation expectations are neither unbiased nor efficient, while 1-month ahead inflation surveys are.

20. ***For policy purposes, low inertia implies that responding to inflationary shocks entails more limited output losses.*** The results also underscore the role of consistent macroeconomic policies for anchoring inflation expectations, with fiscal credibility playing an important role. The increase in credibility of the central bank since the move to a flexible exchange rate regime bodes well for a gradual move to a full-fledged inflation targeting regime. As discussed in the next chapter, further increasing credibility will require increasing the clarity of objectives and procedures of monetary policy. Still, the evidence on the rationality of the forecasts is mixed. This suggests that further efforts in enhancing policy communications may help agents improve their forecasts and assist the authorities in anchoring expectations.

⁴ This result also holds for the shorter 12-month survey available from the central bank.

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Appendix: Co-integration Tests, Bivariate VEC Model, and Tests of Efficiency of Inflation Forecasts

Table A1. Johansen Co-integration Test Results

	Trace statistic for alternative trend assumptions	
	Source of inflationary expectations	
	Consensus forecasts	Central bank of Uruguay
No intercept, no trend	12.7 (0.043)	35.3 (0.000)
An intercept, no trend	20.3 (0.049)	49.6 (0.000)
An intercept, a linear trend	19.9 (0.010)	49.1 (0.000)
An intercept & a trend, a linear trend	29.3 (0.018)	52.3 (0.000)
An intercept, quadratic trend	29.3 (0.001)	51.5 (0.000)

p-values for the null: none cointegrating equations are reported in parenthesis. 2 lags were used as indicated by Schwartz criterion.

Table A2. Adjustment Coefficients in a Bivariate VEC on Actual and Expected Inflation

Source of inflationary expectations	Consensus forecasts, 12-month ahead	
	Expectations regression	Actual inflation regression
Adjustment coefficients	-0.15*	0.13*
t-statistics	(0.067)	(0.061)
Sample period	1998:01-2006:09	
Source of inflationary expectations	Central bank of Uruguay, 1 month ahead	
	Expectations regression	Actual inflation regression
Adjustment coefficients	-1.41*	-0.63
t-statistics	(0.34)	(1.05)
Sample period	2004:04-2006:09	

Table A3. Tests of Efficiency of Inflation Forecasts

<i>12-month ahead forecast horizon</i>			
Sample period: 1993:03-2006:09			
No. Observations: 163			
Dependent variable	Regressors	Chi-square	p-value
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of Inflation	21.71	0.0002
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of primary balance	10.42	0.034
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of real wage gap	19.24084	0.0007
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of real effective exchange rate gap	8.933186	0.0628
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of Year-on-year M1 growth	18.59057	0.0009
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of unemployment rate	25.35912	0.0000
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of Year-on-year exchange rate change	70.51959	0.0000
<i>1-month ahead forecast horizon</i>			
Sample period: 2004:01-2006:09			
No. Observations: 33			
Dependent variable	Regressors	Chi-square	p-value
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of Inflation	14.60901	0.0056
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of primary balance	5.496805***	0.2400
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of real wage gap	2.534467	0.6385
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of real effective exchange rate gap	9.135744	0.0578
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of Year-on-year M1 growth	4.018122	0.4036
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of unemployment rate	2.907312	0.5735
\mathcal{E}_{t+12}	Constant, lags 1 to 3 of Year-on-year exchange rate change	6.910537	0.1407

II. PASS-THROUGH, DOLLARIZATION, AND CREDIBILITY IN URUGUAY

By Alejandro López Mejía, Alessandro Rebucci, and Carolina Saizar

A. Introduction

1. ***A high degree of exchange rate pass-through to domestic prices and financial dollarization can constrain the effectiveness of a flexible exchange rate as a shock absorber and indirect channel of transmission of monetary policy.*** Accordingly, pass-through and financial dollarization have been considered key obstacles to the design and implementation of an independent monetary policy in Uruguay since the 2002 crisis, when the exchange rate was allowed to float. A poorly (well) functioning monetary policy framework in a flexible exchange rate regime, in turn, may hamper (foster) the country's ability to maintain macroeconomic stability and insulate the real side of the economy from shocks.
2. ***This paper documents the recent evolution of pass-through and investigates the scope for reducing dollarization through enhanced monetary policy credibility.*** In line with developments in other emerging markets, the paper finds that the exchange rate pass-through in Uruguay has declined over the years. However, the results suggest that it has become volatile and unstable since late 2005, when the authorities moved away from the free float adopted in the aftermath of the 2002 crisis. Also, consistent with theory and other experiences (See Borensztein et al (2004), Jeanne (2002), and Rajan (2004) among others), it finds that monetary policy credibility affects financial dollarization, although long periods of time may be needed for credibility to deliver its benefits and for dollarization to decline.
3. ***The policy implications of these findings are important.*** A lower exchange rate pass-through to domestic prices implies that the exchange rate can work well as a shock absorber and is less effective as a nominal anchor. Thus, the exchange rate could be allowed to float more freely in response to normal shocks. To the extent that positive capital account shocks have a temporary component, greater exchange rate flexibility would be consistent with “leaning against wind” to further accumulate reserves, thus adding insurance against balance of payments crises; it is also consistent with intervening for foreign exchange liquidity provision in response to sudden and large negative capital account shocks given that, with high dollarization, large exchange rate fluctuations generate balance sheet effects that can destabilize the real economy and the financial sector.¹ Improving credibility should become a priority as it can help lower dollarization, reducing vulnerabilities to external shocks and enhancing the transmission mechanisms of monetary policy. This, in turn, would increase the economy's ability to implement effective stabilization policies, thus fostering an environment conducive to financial development and growth.

¹ These implications are consistent with a formal analysis of alternative monetary policy responses in economies potentially vulnerable to sudden stops (Benigno, Otkok, Rebucci, and Young (2007a and b)).

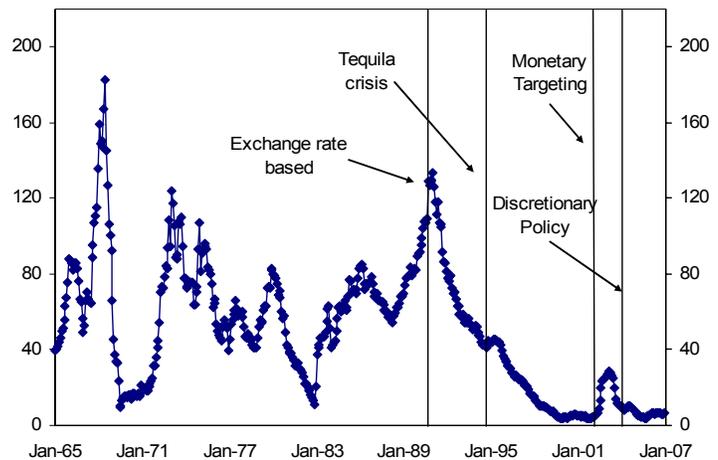
B. Background

4. *This section describes the evolution of the monetary policy framework and the constraints to the channels of transmission of monetary policy in Uruguay.* It underlines the importance of increasing the clarity of objectives and the transparency of operations under the existing framework to increase credibility.

The evolution of the monetary policy framework

5. *Uruguay's long history of monetary instability came to an end with a successful exchange-rate-based stabilization during the 1990s.* Starting in late 1990, the authorities allowed the peso to move within a crawling band that was depreciated at a declining rate, but in excess of domestic inflation to help strengthen external competitiveness. This policy helped anchor inflationary expectations and brought inflation down to 4 percent in 1999 from over 100 percent in 1990 (Figure 1).

Figure 1. Inflation in Uruguay



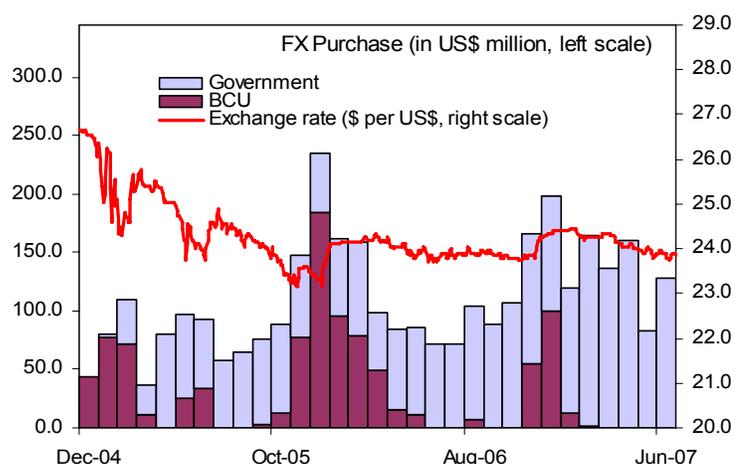
6. *A revealed preference for single digit inflation has emerged since the late 1990s.* During the last eight years, average annual inflation has fluctuated within $3\frac{1}{2}$ and $9\frac{1}{3}$ percent. An exception was 2002, when end-year inflation reached 26 percent following the financial crisis—still a moderate increase compared to the inflation experienced in previous decades.²

7. *The monetary framework that was adopted in the midst of the 2002 financial crisis has evolved gradually.* Initially, the exchange rate was allowed to float in June 2002 and base money targets were selected to anchor the system starting in early 2003. In 2004, a band for base money (rather than a point) became the monetary target and, at the end of each quarter, the central bank began to announce a target for the annual headline consumer price inflation, twelve months in advance. In late-2005, the authorities moved away from the free float and

² The crisis was triggered by deposit withdrawals from cash-strapped Argentine residents that soon developed into a more generalized run on the banks (IMF, 2003).

adopted M1 as the intermediate target, keeping the base money range as the operational target; since then, significant foreign exchange purchases, partly undertaken by the government to meet its foreign currency needs, have succeeded in maintaining the nominal exchange rate broadly stable (Figure 2). In 2006, the central bank stopped announcing base money targets and extended the inflation target band to 18 months (still with the possibility of revising it at the end of each quarter) (De Brun and Licandro (2005), Aboal, Lanzilotta, and Perera (2006)).

Figure 2. Nominal exchange rate and foreign exchange rate intervention



8. *Under these circumstances, the existing monetary framework appears to have multiple objectives.* In particular, by mid-2007, the authorities were simultaneously targeting (and announcing) M1, the inflation rate, and had an apparent exchange rate target. This ambiguity may also reflect the fact that the mandate of the central bank is not exclusively to maintain low inflation. According to the law, other objectives of the central bank are to maintain an adequate level of international reserves and the stability of the financial system. In addition, although an exchange rate objective is not specified in the central bank's formal mandate, the exchange rate has in practice been a policy objective due to concerns related to competitiveness and the balance sheet effects associated with dollarization.

9. *Under the existing monetary regime, consistency among the main objectives of monetary policy is essential.* While during the 1990s the exchange rate was a clear and transparent nominal anchor, the appearance of multiple objectives and the lack of transparency on the relative importance of each of these objectives under the existing framework leaves the system without a clear anchor and undermines its credibility. For instance, if the exchange rate is perceived as a policy objective per se, the authorities' inflation target may be ignored by the public when forming their expectations about inflation. Thus, there is strong need to be transparent regarding the role of the exchange rate to help strengthen the effectiveness of monetary policy (Mishkin and Savastano, 2000). In this context, limiting foreign exchange intervention by the state bank would minimize market perceptions of exchange rate "floors" and need to be coordinated with the central bank (Aboal, Lorenzo and Loya, 2003).

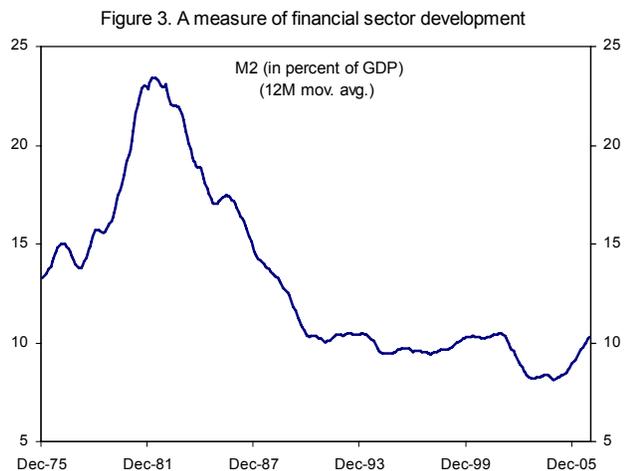
The transmission mechanisms of monetary policy and its implications

10. *The channels through which monetary policy is transmitted to prices and output face several constraints in Uruguay.* If the exchange rate plays a key role in the price setting process, a flexible exchange rate could lead to high variability in inflation and increase

dollarization (Ize and Levy Yeyati, 2006). A high pass-through also reduces the effectiveness of the exchange rate as indirect channel of transmission to output and prices, since changes in the exchange rate would have a limited impact on net exports. The existence of a high pass-through in Uruguay is consistent with a large share of tradable goods in the consumer basket (about 60 percent).³ Also, a history of monetary instability might have led the public to try to isolate the impact of changes in the exchange rate on real income by linking price and wage contracts to changes in the value of the *peso* against the dollar.

11. ***High financial dollarization makes inflation expectations harder to anchor and reduces the effectiveness of monetary policy to affect aggregate demand.*** High financial dollarization reduces the effectiveness of the interest rate channel because the central bank has limited control over the dollar yield curve of interest rates. Thus, changes in money supply in domestic currency have a limited impact on savings and aggregate demand (see Varela-Loschiavo and Vera-Iglesias, 2003). Dollarization also weakens the exchange rate channel: an expansionary monetary policy, that could increase the demand for domestic goods through the impact of a real devaluation, may lead to financial distress and an economic contraction due to balance sheet effects.

12. ***Low financial intermediation and the structure of the financial system also weaken the channels of transmission of monetary policy.*** With relatively low financial intermediation, personal savings and retained earnings play a key role in financing consumption and investment and the effectiveness of the interest rate and lending channels is more limited (Figure 3).⁴ Also, in the case of Uruguay, the presence of a large state-owned bank, representing about



50 percent of the system, potentially weakens the lending channel. A monetary contraction, for example, may not necessarily lead to a reduction of bank's loanable resources because the government can have an incentive to provide the bank with the needed resources to avoid a reduction in lending and output. Still, as discussed in Chapter IV, while still low, the lending channel is becoming more important (Gelos and Piñón, 2007).

³ A high pass-through is usually associated to high real dollarization (Armas, Batini and Tuesta, 2007). In Uruguay, existing evidence indicates that the elasticity of prices with respect to the exchange rate is about 0.5 in the long run (Licandro, 2000).

⁴ De Brun et.al (2006) find that retained earnings and bank lending represent 45 and 25 percent of total financing of corporations.

13. ***Enhancing credibility of monetary policy would help relax these constraints.***

Credibility is essential for the expectation channel of monetary policy to work and for a sustained process of dedollarization to occur. Reduced dollarization would help increase the effectiveness of other transmission channels and makes monetary policy more effective in stabilizing the economy. This, in turn, could lead the private sector to require less real and financial hedging against the risk of instability, thus reducing dollarization and the vulnerability of the economy to crisis. The next two sections study the evolution of pass-through and investigate the scope for reducing financial dollarization through enhanced credibility.

C. Has Pass-Through Declined in Uruguay?

14. ***A standard methodology was used to assess the evolution of the exchange rate pass-through to the consumer price index (CPI) and the producer price index (PPI).***

Following Campa and Goldberg (2002), as adapted by Edwards (2006) to the analysis of changes in exchange rate pass-through after the adoption of inflation targeting regimes, the following equation was estimated by ordinary least squares using monthly data:

$$(1) \quad \Delta \log P_t = \beta_0 + \beta_1 \Delta \log E_t + \beta_3 \Delta \log P_t^* + \beta_4 \Delta \log P_{t-1} + \omega_t$$

where P_t is the price index (the consumer and producer price indexes were used as proxies for nontradable and tradable inflation, respectively), E_t is the nominal exchange rate, P_t^* is the U.S. producer price index (a proxy for world inflation), and ω_t is an error term with standard characteristics. The short term pass-through is given by β_1 and the long term pass-through is $\beta_1/(1-\beta_4)$. For a nominal exchange rate to be an effective shock absorber or help transmit monetary policy impulses indirectly, the pass-through for nontradables needs to be smaller than that for tradables: a nominal devaluation leads to a real depreciation, helping generate and expenditure switching effect, thus affecting net exports and the output gap.

15. ***The results indicate that the pass-through has declined since the 2002 crisis and it is now higher for tradables than for nontradables.*** Table 1 presents the estimated short-run and long-run pass-through coefficients for the CPI and PPI equations for Uruguay, and a set of comparator countries analyzed by Edwards (2006). In the case of Uruguay, the sample is divided into pre-crisis (September 1990–September 2002) and post-crisis (December 2002–September 2005) periods. The pass-through coefficient (short and long term) declined after the 2002 crisis for tradable and nontradable goods. While the pass-through coefficients for nontradables are now lower than for tradables, they were higher before the 2002 crisis—probably due to the importance of backward looking wage indexation mechanisms during the 1990s. The pass-through coefficients vary considerably across countries, with higher values in economies that experienced high inflation (e.g., Brazil, Israel, Mexico, and Uruguay).

Table 1. Short- and Long-Run Exchange Rate Pass-Through, Selected Countries 1/

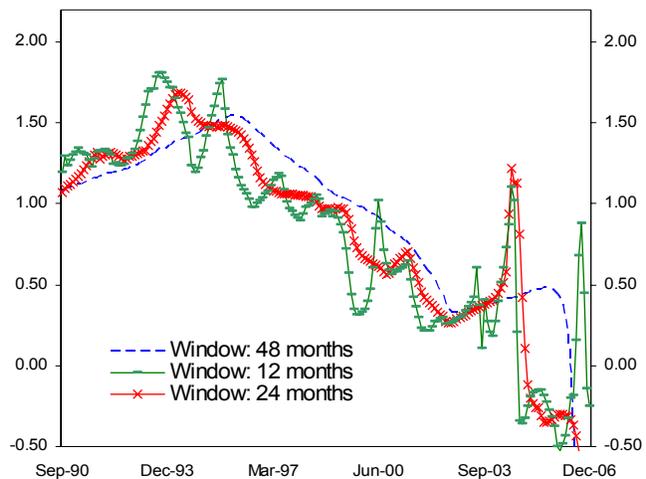
Country	CPI				PPI			
	Short-Run Pass-Through		Long-Run-Through		Short-Run Pass-Through		Long-Run Pass-Through	
	Pre-IT	Post-IT	Pre-It	Post-IT	Pre-It	Post-IT	Pre-It	Post-IT
Uruguay 1/	0.56	0.24	1.4	0.45	0.41	0.39	1.17	0.76
Australia	0.054	0.000	0.120	0.000	0.070	0.070	0.070	0.070
Brazil	0.719	0.056	1.027	--	0.759	0.235	1.060	0.697
Canada	0.039	0.000	0.078	0.000	0.085	0.085	0.143	0.143
Chile	0.137	0.005	0.212	0.008	0.207	0.045	0.257	0.056
Israel	0.624	0.197	0.718	--	0.627	0.197	0.713	0.224
Korea	0.020	0.020	0.025	0.025	0.055	0.055	0.070	0.070
Mexico	0.191	0.015	0.523	0.018	0.246	0.246	0.591	0.316

Source: Edwards (2007).

1/ Before and after the 2002 crisis; monthly data. The specification includes one lag (or automatic specification search starting from six lags in Pcgets) before the crisis. After the crisis it uses an automatic specification search, starting from six lags.

16. *An alternative methodology yields similar insights.* Static OLS rolling regressions with different estimation windows, which can each be interpreted as a cointegration relation, indicate that the pass-through to the CPI began to decline much earlier (around 1994–95), as the level and volatility of inflation declined (Figure 4). While the regressions suggest a sharp increase in the pass-through following the 2002 crisis, they also show a subsequent decline to below the pre-crisis level, consistent with the result in Table 1. However, the switch to a managed float regime seems to be associated with a strong instability of the pass-through, with the 12-month window suggesting that it could be on the rise again.

Figure 4. Pass-through rolling regression coefficients

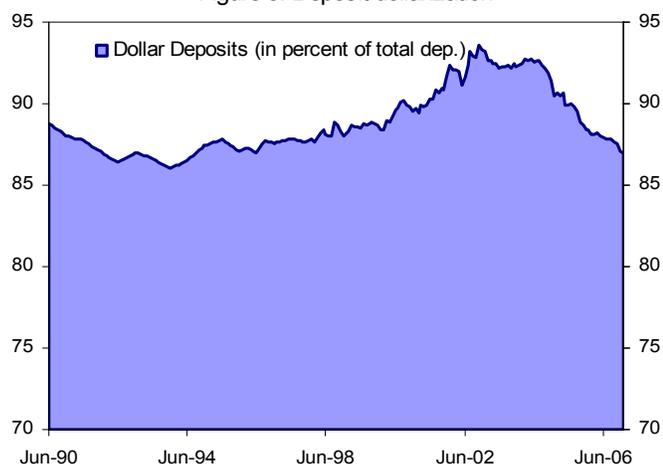


17. *The exchange rate cannot be an effective nominal anchor when the pass-through is unstable.* Indeed, under these circumstances, exchange rate movements have an uncertain impact on inflation. At the same time, the exchange rate is now a more effective shock absorber, with the exchange rate pass-through for nontradables being smaller than that for tradables. Therefore, the exchange rate should be allowed to float more freely in response to normal shocks. Nevertheless, high dollarization is still a constraint to a floating exchange rate as large fluctuations would induce destabilizing balance sheet effects.

D. Is Monetary Policy Credibility Linked to Financial Dollarization?

18. ***Financial dollarization is very high and persistent in Uruguay.*** A traditional measure of financial dollarization is the share of dollar deposits in total deposits of the banking system (Figure 5). Financial dollarization can also be measured as the share of dollar credit in total credit of the banking system (Figure 6). In Uruguay both measures of dollarization are very high and persistent, with credit dollarization somewhat lower and more volatile than deposit dollarization.

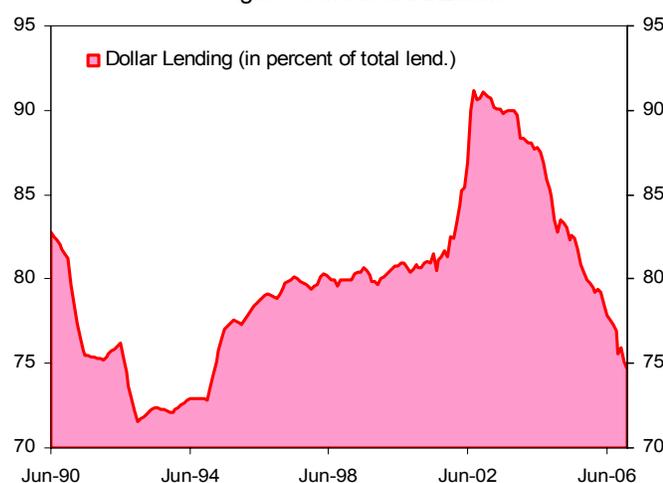
Figure 5. Deposit dollarization



19. ***Credibility can be broadly defined as the public's degree of confidence or uncertainty regarding the government's policy objectives.*** Monetary policy credibility can thus be measured as the probabilistic distance between the expected policy outcomes and the publicly announced policy targets. The measure adopted here is the difference between expected inflation and the inflation target, normalized by the variance of expected inflation. Thus,

credibility = $(E\pi_t - T\pi_t) / (8 * V\pi_t^{0.5})$, where $E\pi_t$ is expected (unconditional) mean inflation at time t , $T\pi_t$ is the inflation target, and $V\pi_t^{0.5}$ is the standard deviation of unconditional mean inflation. This measure is approximately bounded between -1 and +1, if the standard deviation of mean inflation is multiplied by a factor of 8, and theoretically “perfect”, when expected inflation is equal to the inflation target, at zero.⁵ The numerator quantifies the distance between expected inflation and the inflation target (i.e., it provides a signal on the direction and magnitude of the deviation of expectations from target). The denominator quantifies the uncertainty regarding such deviations (the noise surrounding the signal). For instance, a large

Figure 6. Credit dollarization



⁵ See appendix for more details.

deviation of expectations from the inflation target associated with high uncertainty may result in the same credibility level than a relatively smaller deviation with lower uncertainty.

20. ***According to this measure, credibility has fluctuated widely since the late 1990s and has lately fallen.*** Broadly in line with previous findings (Masoller, 1997), monetary policy credibility appears to have been very “close to perfect” during the last years of the exchange-rate-based stabilization period, reflecting a small undershooting of expected inflation compared to the target and little uncertainty about those deviations.⁶ Credibility started to deteriorate just before the crisis, but it took three years before reverting to the pre-crisis levels. This latter improvement was partly due to a second wave of uncertainty, possibly associated with the changes in the monetary procedures and framework in 2005 (Figure 7). This measure of credibility suggests that since 2006, there has been a moderate but persistent deterioration in credibility, with small deviations of expected inflation from the target associated with progressively less uncertainty about those deviations.

21. ***Financial dollarization and credibility are closely associated.*** This holds for the pre and post-crisis periods, with a sample correlation of around 0.8, and is confirmed by a more formal analysis (Figure 8). A simple VAR analysis shows that lower credibility increases dollarization persistently (Figure 9).⁷ Thus, enhancing the credibility of monetary policy could help reduce financial dollarization, which, in turn, would make monetary policy more effective. However, consistent with evidence from other

Figure 7. A Measure of Credibility

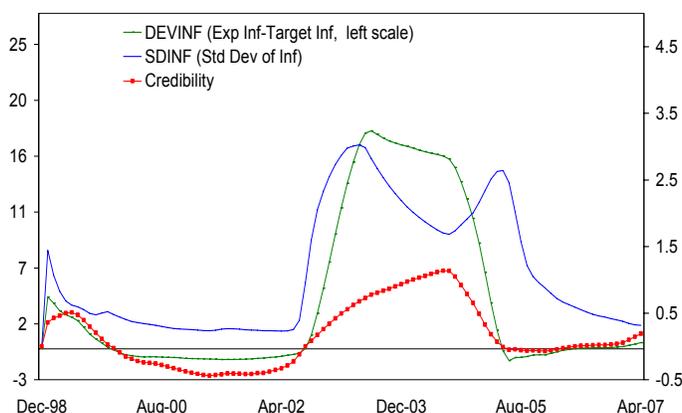
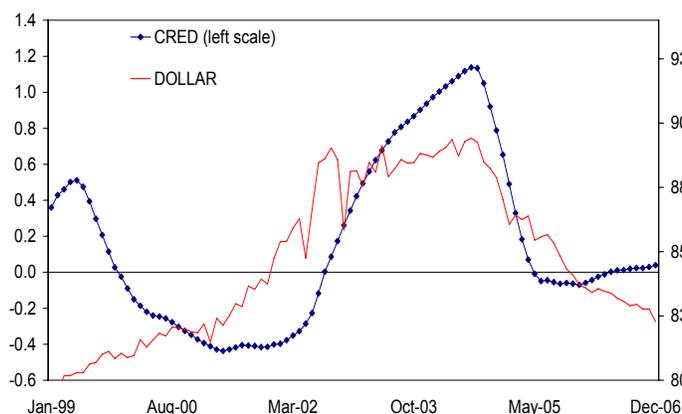


Figure 8. Financial Dollarization and Credibility

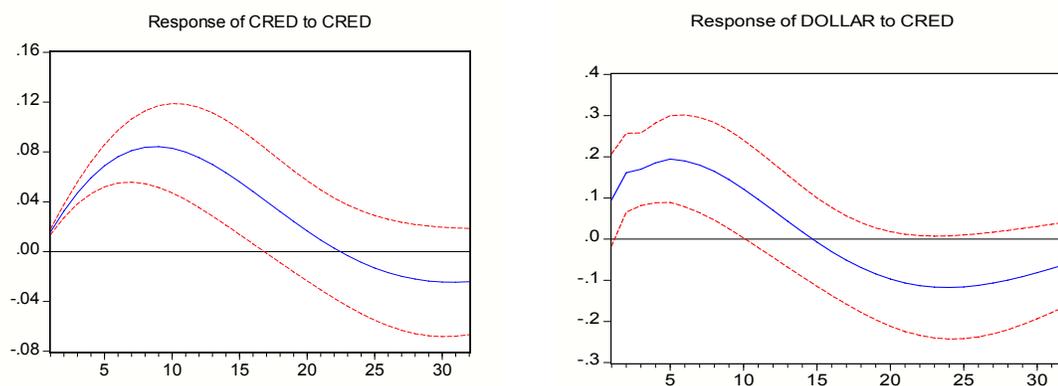


⁶ This evidence is robust to two alternative measures of credibility: the difference between consensus forecast inflation and the inflation targets under the IMF programs, and the difference between expected depreciation (as implied by the interest rate differential between dollar and peso bank deposits) and actual depreciation under of the upper band of the crawl.

⁷ For identification purposes, the VAR assumes that dollarization does not affect credibility within a month. The VAR includes the measure of credibility above and the share of dollar deposits in total deposits by residents, together with three lags of each variable, a constant and a linear trend, and Argentine and Uruguayan country spreads. Data are monthly and the sample period is from January 1999 to December 2006.

countries (Borensztein et. al 2004), credibility is likely to take a long time to deliver its benefits and for dollarization to decline. For instance, between February 2004 and May 2005 credibility improved from 1 to zero, but deposit dollarization changed only by 4 percentage points (to 90 percent of total deposits).

Figure 9. Impulse response functions



E. Conclusions

22. ***The exchange rate pass-through to domestic prices has declined over the last decade although it has become unstable since late-2005.*** This implies that the exchange rate is now a less effective nominal anchor and, therefore, the role of an appreciation in offsetting inflationary pressures, while still important, has diminished. It also means that the exchange rate can generate expenditure-switching effects, thus helping isolate the economy from shocks. Accordingly, the exchange rate should be allowed to float more freely in response to normal shocks. However, high dollarization is still a constraint to a floating exchange rate as exchange rate fluctuations generate balance sheet effects that can destabilize the real economy and the financial sector. In this context, intervening in the foreign exchange market in response to financial shocks is justifiable. Clarity on they rational for intervening and transparency of intervention procedures may help increase the effectiveness of such interventions and facilitate floating more freely in response to other shocks.

23. ***Improving monetary policy credibility would help reduce dollarization, a key constraint to monetary policy in Uruguay.*** Enhancing credibility would strengthen the expectation channel of monetary policy and, by reducing dollarization, would increase the effectiveness of other transmission channels and make monetary policy more credible for stabilizing the economy. This, in turn, could lead the private sector to require less hedging against the risk of instability, thus reducing the vulnerability of the economy to crisis and increasing long-term growth prospects.

24. ***There is scope to secure credibility gains in Uruguay.*** In particular, the credibility of its monetary framework can be improved by: (i) strengthening *de facto* the operational independence of the central bank through its recapitalization and a clear commitment to subordinate the exchange rate to the inflation target; (ii) enhancing the communication

strategy to ensure that markets understand well the monetary policy strategy, and the instruments and procedures for its implementation; (iii) further strengthening the financial sector to help increase the effectiveness of monetary policy, and (iv) further developing analytical capabilities to enhance the capacity of the central bank to forecast inflation and to understand better how adjustments in policy settings are transmitted into inflation.

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Appendix: Measuring Credibility

The methodology adopted to measure credibility is that proposed by Rebucci and Rossi (2006; the RATS code is available on request from the authors). The procedure assumes that a representative agent “learns” in a Bayesian manner, knowing the econometric model of the inflation process, but with only beliefs (i.e., prior probability distributions) about its parameters. The agent updates these beliefs on the basis of realizations of the inflation process, to form posterior distributions about inflation and its characteristics. By manipulating these posterior distributions, a statistical or probabilistic measure of the distance between actual and target inflation, after each realization of the inflation process, can be computed.

To implement this methodology, three objects are needed. First, an inflation target; second, an econometric model of the disinflation process; and third, an estimation procedure to implement econometrically Bayesian learning about the inflation process and its characteristics. The assumed inflation target is a single digit inflation range, between four and six percent, similar to the current inflation target of the authorities; alternative values for the target---namely, four, five, or six percent---yield similar results (not reported). It was assumed that inflation follows a simple AR1 process: $\pi_t = \alpha + \beta \pi_{t-1} + e_t$; $e_t \sim N(0, \sigma^2)$, where α is the conditional mean of inflation, β is the conditional persistence of temporary deviations from this mean, and σ^2 is the conditional volatility of the shocks producing these deviations.

The procedure focuses on the unconditional mean of inflation, given by $(\alpha/(1-\beta))$. The mixed estimator is used to update the posterior distributions of α and β , after each realization of the inflation process, thus providing for a very simple estimation procedure (see Rebucci and Rossi (2006). For instance, given agents’ prior on the model parameters at time T-1, say $\alpha(T-1)$ and $\beta(T-1)$, where T-1 is the month before the inflation target announcement, mixed estimation of the equation above over the sample period from T-S to T, where S is the fixed-length of the estimation window (24 months in our application), provides a posterior distribution of $\alpha(T)$ and $\beta(T)$. These posterior distributions can then be used as prior for T+1, and the posterior at time T+1 as prior at T+2, and so on. Given a sequence of posterior distributions, which are approximately normal if computed based on mixed estimation of the equation above, the approximate expected value and standard deviation of $(\alpha/(1-\beta))$ can be easily computed, and hence our credibility measure described in the main text. Specifically, it can be shown that, for a given joint distribution of (α, β) , the mean and the standard deviation of $g(\alpha, \beta) = (\alpha/(1-\beta))$ can be approximated as follows:

$$\begin{aligned}
 E[g(\alpha, \beta)] &\approx g(E\alpha, E\beta) + 0.5 \cdot V[\alpha] \cdot \partial^2 g(E\alpha, E\beta) / \partial \alpha^2 + 0.5 \cdot V[\beta] \cdot \partial^2 g(E\alpha, E\beta) / \partial \beta^2 + \\
 &Cov[\alpha, \beta] \cdot \partial^2 g(E\alpha, E\beta) / \partial \alpha \partial \beta \\
 Var[(\alpha, \beta)] &\approx V[\alpha] \cdot \{\partial g(E\alpha, E\beta) / \partial \alpha\}^2 + V[\beta] \cdot \{\partial g(E\alpha, E\beta) / \partial \beta\}^2 + \\
 &2Cov[\alpha, \beta] \cdot \{\partial g(E\alpha, E\beta) / \partial \alpha \cdot \partial g(E\alpha, E\beta) / \partial \beta\}
 \end{aligned}$$

where $E\alpha$, $E\beta$, $V[\alpha]$, $V[\beta]$, and $Cov[\alpha, \beta]$ are the moments of the joint distribution of (α, β) .

III. EXTERNAL FINANCIAL LINKAGES: WHAT DRIVES URUGUAYAN SOVEREIGN SPREADS?

By Gustavo Adler and Stephanie Eble

A. Introduction

1. ***This chapter examines the determinants of Uruguayan sovereign spreads.*** It analyzes whether sovereign spreads have been largely driven by economic fundamentals or by external factors. It also assesses the relationship between the spreads of Uruguay and those of other emerging market economies (EMEs)—particularly neighboring countries—and the change in such relationship since the 2002–03 crisis.
2. ***The results suggest that, while fundamentals explain part of the variance of sovereign spreads, external factors also play an important and—surprisingly—growing role.*** Moreover, external factors have become more important since the 2002–03 financial crisis, following Uruguay’s loss of investment grade.¹ While in the late 1990s Uruguay was largely insulated from regional and EME shocks, since the crisis Uruguayan spreads have moved closely with those of neighboring countries. Similarly, unlike the 1990s when Uruguayan spreads were at the level of—and co-moved with Chilean spreads (an investment grade economy), after the crisis Uruguay’s spreads shifted to the level of—and began co-moving with other non-investment grade countries in the region. Econometric estimates point to heightened financial spillovers from other EMEs, following the downgrading of Uruguay’s credit rating, suggesting a change in investors’ perception of Uruguay’s vulnerability to external financial conditions.
3. ***Today, despite important achievements, Uruguay is still perceived by investors as more vulnerable to global and regional shocks than before the crisis.*** Thus, despite important improvements in the last years, it will be essential to sustain sound policies to further delink Uruguay’s fortunes from those of other EMEs and global conditions. Continuing to strengthen the macroeconomic framework and implementing pending structural reforms will be key in this regard. Regaining investment grade status would also likely help insulate Uruguay to a large extent from a possible turnaround in global conditions and from regional shocks.

B. Stylized Facts

4. ***Following the 2002–03 crisis, Uruguay’s sovereign spreads have declined significantly.*** After peaking in the midst of the crisis, spreads sharply dropped with the completion of the debt restructuring in mid-2003. Since then, they continued a sharp

¹ In the remainder of the paper, credit ratings refer to foreign currency long-term debt.

downward trend, reaching pre-crisis levels by end-2005 (Figure 1). This has allowed the government to tap markets at very favorable rates and to significantly improve the profile of public debt.

5. The marked fall in sovereign spreads has been accompanied by significant improvements in country fundamentals. Strong fiscal

consolidation, high output growth, and the recovery of the real exchange rate from its post-crisis lows have contributed to a sharp reduction of public debt as a share of GDP, alleviating solvency concerns. In addition, liquidity indicators have improved substantially, with reserve coverage of short-term external debt and foreign currency deposits well above pre-crisis levels, partly reflecting a sharp reduction in short-term debt (Figure 2). Furthermore, the recovery of the financial system has reduced contingent fiscal liabilities.

Figure 1. Uruguay and Global EMBI Spread, 1996-2006 1/

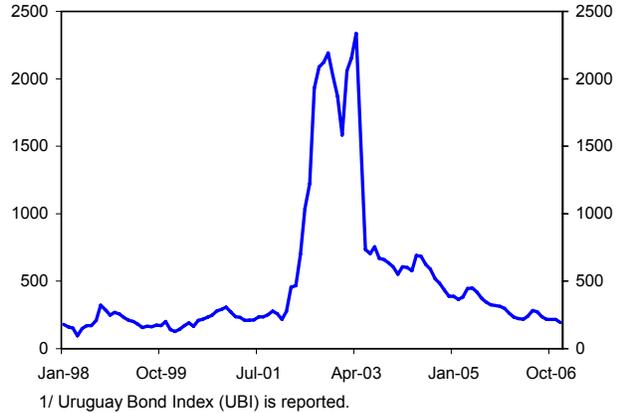
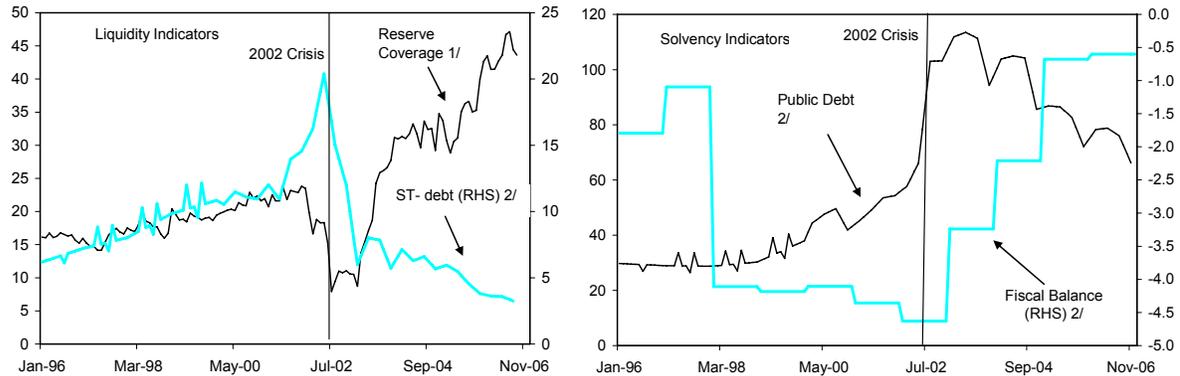
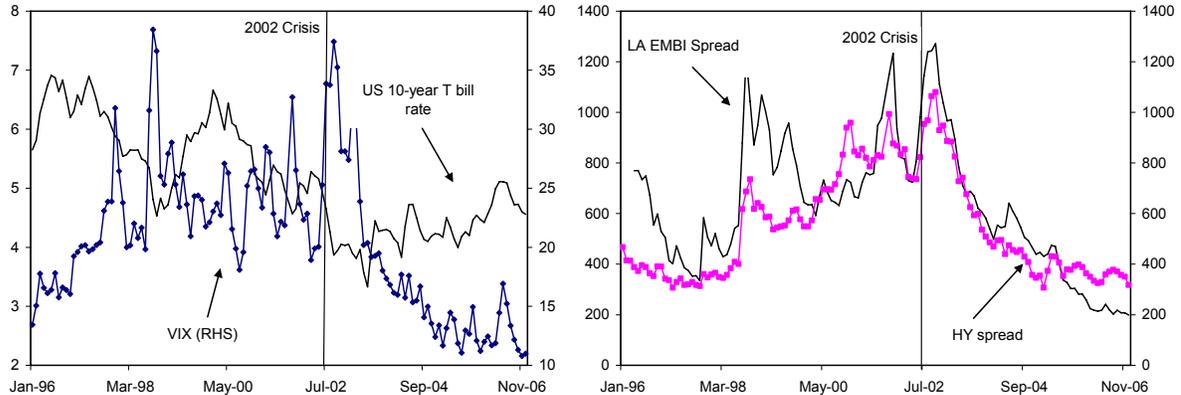


Figure 2. Country Fundamentals and External Factors, 1996-2006

Country Fundamentals



External Conditions



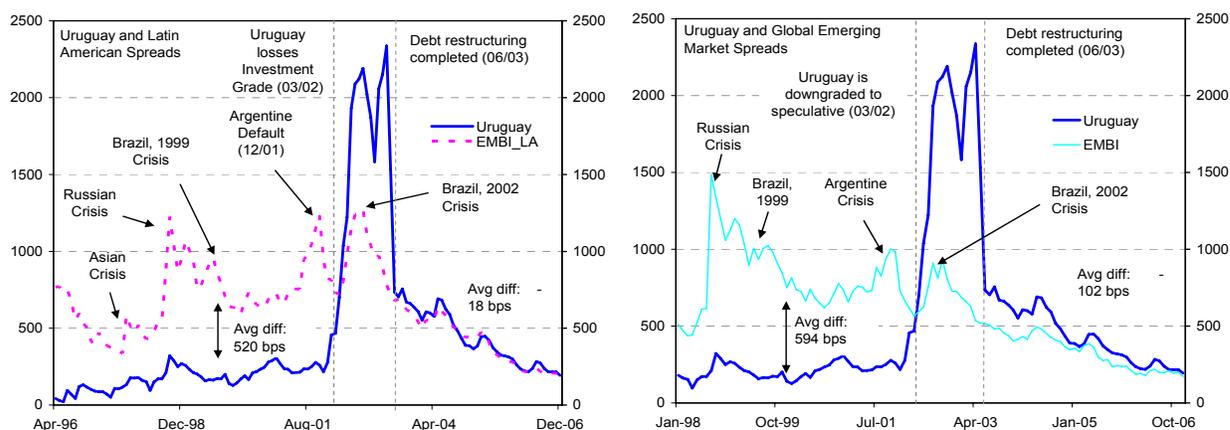
1/ Gross international reserves over ST external debt and foreign currency deposits
 2/ As percent of GDP.

6. *At the same time, Uruguay has benefited from a very benign global environment.*

Global financial conditions have improved markedly since 2002. Long-term U.S. interest rates have declined significantly, financial market volatility—a proxy for liquidity conditions—has reached historical lows, and U.S. corporate high yield spreads have also fallen.² Reflecting this favorable environment, emerging market sovereign spreads have followed a steady downward trend across the board, reaching historical lows in 2006.

7. *During the late 1990s Uruguay's sovereign spreads were largely insulated from financial shocks in other EMEs.* They remained significantly below those of neighboring countries—about 500 bps below the Latin American EMBI during 1998–2001—and were only weakly correlated with them. This is likely to have reflected Uruguay's investment grade and the general perception of Uruguay as a safe haven for investment in the region (Figure 3). A similar pattern is found when compared to the global EMBI.

Figure 3. Uruguay, Latin American and Global EMBI spreads, 1996–2006 1/



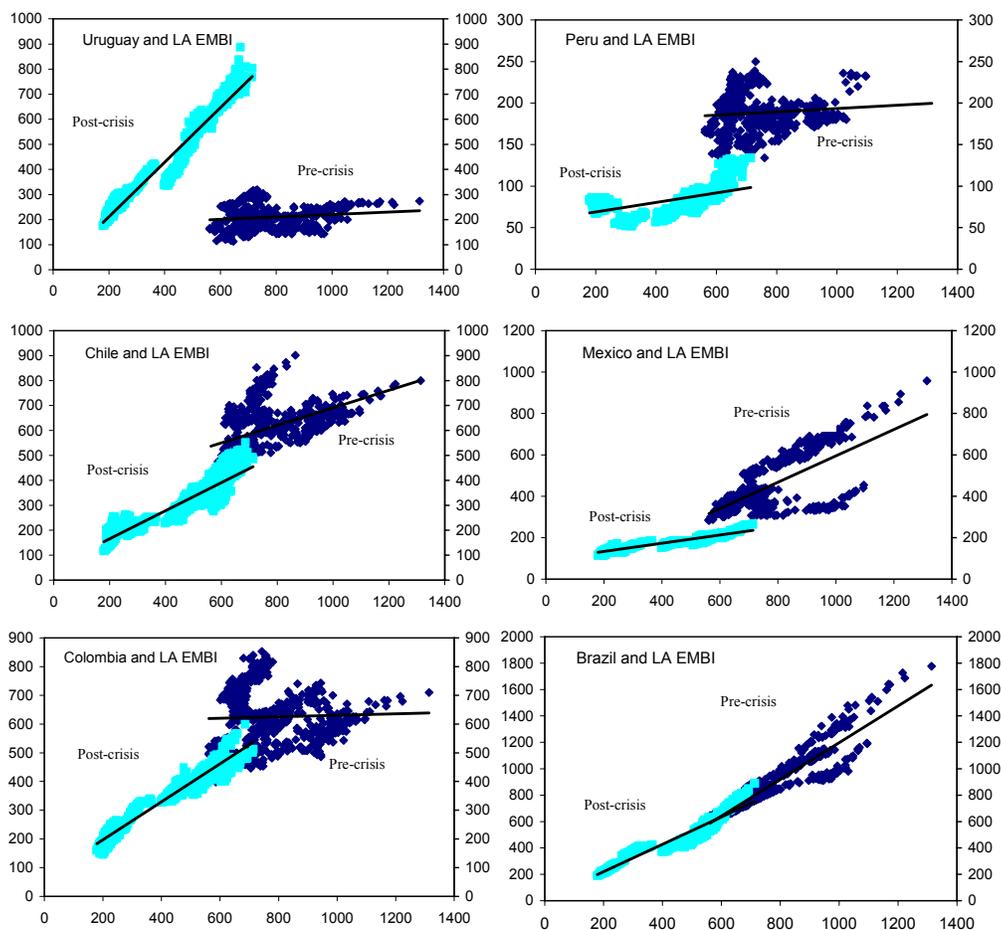
1/ For Uruguay, the Uruguayan Bond Index (UBI) is reported; for Latin American and Global Emerging Markets the JP Morgan EMBI spread is reported.

8. *In 2002–03, Uruguay's sovereign spreads spiked in the mist of the financial crisis rooted in the withdrawal of Argentine deposits from the Uruguayan banking system.* A severe contraction of the economy, a depreciation of the peso, and a marked increase in public debt led to debt sustainability concerns and to sharp increases in sovereign spreads to above 2000 bps. With the voluntary debt restructuring—which did not imply any hair cut, but a small NPV reduction—some measure of market confidence was rapidly restored. Still, sovereign spreads remained significantly above pre-crisis levels, reflecting continued concerns about Uruguay's repayment capacity and the loss of investment grade rating.

² Financial market volatility is proxied by the Chicago Board Options Exchange Volatility Index, a popular measure of the implied volatility of S&P 500 index options, which aggregates market expectations of volatility over the next 30-day period. To measure the average spread of U.S. speculative grade corporate bonds (a proxy for investor risk appetite) the Merry Lynch high yield index is used.

9. *In contrast with the 1990s, since the crisis Uruguayan spreads have remained close to, and have displayed high correlation with, neighboring countries' spreads. Since 2002 Uruguayan spreads have remained at about the level of, and closely co-moved with, the Latin America EMBI. Sovereign spread correlations across countries have generally increased, but Uruguay has been particularly affected (Figure 4). While before the crisis daily correlation with neighboring countries was low, Uruguayan cross border correlations increased after the crisis to the levels displayed by other countries in the region (Table 1).³ Notably, correlation with the Latin American EMBI and the Global EMBI have tripled. Interestingly, while the correlations between Uruguayan and other non-investment grade Latin American countries' spreads have increased, the correlation with Chile has declined.*

Figure 4. Selected country spreads and Latin American EMBI Spread, pre and post Uruguayan crisis. 1/



1/ Argentina is excluded, as most of Uruguay's post-crisis period coincides with the Argentine debt restructuring process.

³ Following Forbes and Rigobon (1999) and Gelos and Sahay (2001), a formal test of increase in correlation, applying the correction for changes in variance, was conducted, confirming the findings. As the variance has fallen in the post crisis period, the adjustment accentuates the increase in correlations.

Table 1. Sovereign Spread Correlation- Pre and Post Crisis (First differences)

Pre-crisis (Jan 1999- April 2002)									
	ARG.	BRAZIL	CHILE	COL.	EMBI	LA	MEXICO	PERU	URUGUAY
ARGENTINA	1.00	0.32	0.02	0.13	0.28	0.31	0.23	0.19	0.08
BRAZIL		1.00	0.08	0.43	0.81	0.75	0.62	0.47	0.18
CHILE			1.00	0.18	0.12	0.11	0.24	0.12	0.21
COLOMBIA				1.00	0.42	0.36	0.47	0.32	0.26
EMBI					1.00	0.96	0.73	0.49	0.21
LATIN_AMERICA						1.00	0.55	0.40	0.18
MEXICO							1.00	0.38	0.30
PERU								1.00	0.14
URUGUAY									1.00
ARGENTINA I/	1.00	0.71	0.08	0.26	0.82	0.89	0.39	0.36	0.26
Post Crisis (June 2003- Dec 2006)									
	ARG.	BRAZIL	CHILE	COL.	EMBI	LA	MEXICO	PERU	URUGUAY
ARGENTINA	1.00	0.05	0.00	0.07	0.35	0.44	0.07	0.05	0.06
BRAZIL		1.00	0.21	0.67	0.82	0.86	0.59	0.63	0.55
CHILE			1.00	0.24	0.28	0.25	0.33	0.23	0.14
COLOMBIA				1.00	0.78	0.74	0.65	0.70	0.59
EMBI					1.00	0.95	0.75	0.69	0.63
LATIN_AMERICA						1.00	0.72	0.68	0.58
MEXICO							1.00	0.61	0.51
PERU								1.00	0.52
URUGUAY									1.00
ARGENTINA I/	1.00	0.62	0.06	0.53	0.69	0.72	0.50	0.45	0.36

I/ Excluding period between default and debt restructuring.

10. ***Furthermore, there is evidence of heightened financial spillover risks following the crisis.*** Before the crisis, Uruguayan spreads were relatively insulated from shocks in other countries in the region, as confirmed by Granger causality tests between Uruguayan and Latin American spreads based on daily data (Table 2). With exception of Argentina—with which Uruguay had strong trade and financial links—changes in neighboring countries’ spreads did not spill over to Uruguay.⁴ Most notably, the Brazilian and Latin American EMBI’s had no significant effect on Uruguayan spreads.⁵ After the crisis, however, financial spillovers from the region and other EMEs seem to have increased. All pairwise tests show significant causality, pointing to higher vulnerability of Uruguay to regional and global shocks to the emerging market asset class.⁶

⁴ See Eble (2006).

⁵ It is also interesting to note the impact of Uruguayan shocks on Chilean spreads (at 10 percent significance level) in the pre-crisis period, and the following reversion in the direction of causality after the crisis.

⁶ Since the table displays pairwise tests, results should be interpreted with caution. Spillover from small countries in the region is likely to reflect aggregate shocks to either all emerging markets or to the region.

Table 2. Pairwise Granger Causality Tests 1/

Null Hypothesis:	Pre-crisis			Post crisis		
	Obs	F-Stat.	Prob.	Obs	F-Stat.	Prob.
URUGUAY does not Granger Cause BRAZIL	828	1.12	0.327	896	0.90	0.407
BRAZIL does not Granger Cause URUGUAY		1.61	0.200		39.33	0.000 ***
URUGUAY does not Granger Cause CHILE	726	2.56	0.078 *	896	0.40	0.671
CHILE does not Granger Cause URUGUAY		1.51	0.221		7.32	0.001 ***
URUGUAY does not Granger Cause COLOMBIA	828	0.47	0.624	896	0.15	0.864
COLOMBIA does not Granger Cause URUGUAY		0.28	0.757		25.23	0.000 ***
URUGUAY does not Granger Cause EMBI	828	0.96	0.384	896	0.06	0.944
EMBI does not Granger Cause URUGUAY		3.33	0.036 **		28.23	0.000 ***
URUGUAY does not Granger Cause LATIN_AMERICA	828	0.93	0.396	896	0.39	0.680
LATIN_AMERICA does not Granger Cause URUGUAY		1.83	0.161		35.37	0.000 ***
URUGUAY does not Granger Cause PERU	828	0.93	0.396	896	1.40	0.247
PERU does not Granger Cause URUGUAY		1.21	0.300		19.45	0.000 ***
URUGUAY does not Granger Cause MEXICO	828	1.15	0.316	896	0.40	0.672
MEXICO does not Granger Cause URUGUAY		0.29	0.747		18.95	0.000 ***
URUGUAY does not Granger Cause ARGENTINA	828	0.05	0.947	896	0.13	0.880
ARGENTINA does not Granger Cause URUGUAY		6.11	0.002 ***		1.24	0.291
URUGUAY does not Granger Cause ARGENTINA 2/	686	1.70	0.183	375	0.40	0.670
ARGENTINA does not Granger Cause URUGUAY 2/		4.83	0.008 ***		8.62	0.000 ***

1/ Pairwise Granger causality test, for spreads first differences (2 lags). The pre- and post-crisis periods cover Jan 1999-April 2002 and June 2003-Dec 2006 respectively.

2/ Excluding period of debt restructuring (Dec 2001-May 2005).

11. *The heightened financial spillovers seem to be associated with the loss of investment grade.* A simple comparison of sovereign spreads among Latin American countries reveals that during the late 1990s—when Uruguay had investment grade—spreads were significantly lower than those of most neighboring countries and close to the ones of Chile—the other investment grade economy in the region. Furthermore, Uruguayan spreads co-moved with those of Chile during that period. Since the 2002–03 crisis (and the associated loss of investment grade), however, Uruguayan spreads have moved close to those of other non-investment grade economies—with which high correlations are observed (Figures 5 and 6).⁷ Since then, Uruguay’s credit rating has been recovering, but it is still significantly below investment grade.⁸

⁷ Increased correlation and financial spillovers from non-investment grade countries may reflect a change in the set of investors for Uruguayan debt instruments, due to the fact that some institutional investors (often with buy-and-hold strategies) are not allowed to hold instruments with speculative ratings.

⁸ In June 2007, S&P introduced a new methodology for rating sovereign debt issuers according to the expected recovery rate in the event of a default. Interestingly, Uruguay’s recovery rating (2=‘substantial recovery’) is higher than all graded countries in the region. A higher recovery rating combined with a lower overall rating—vis-à-vis neighboring countries—suggests that, despite a good reputation for debt repayment, Uruguay is perceived to be vulnerable to external shocks.

Figure 5. S&P Credit rating for selected Latin American countries, 1994-2007

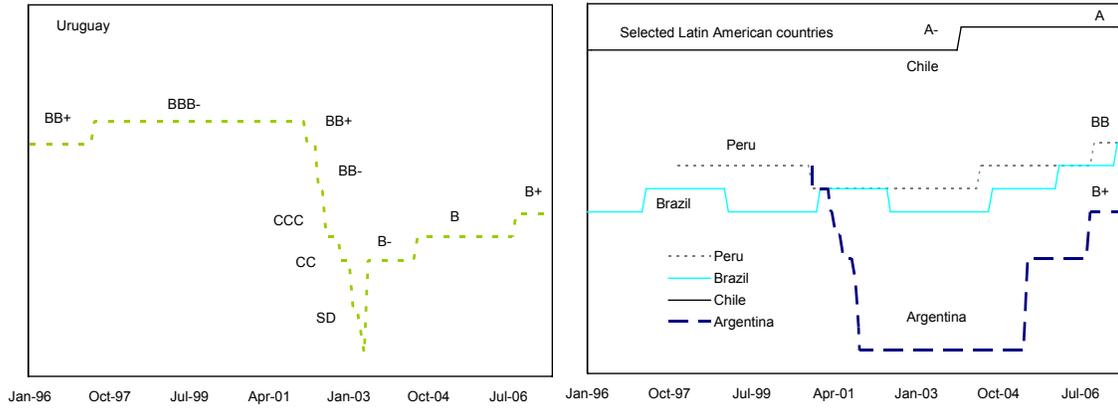
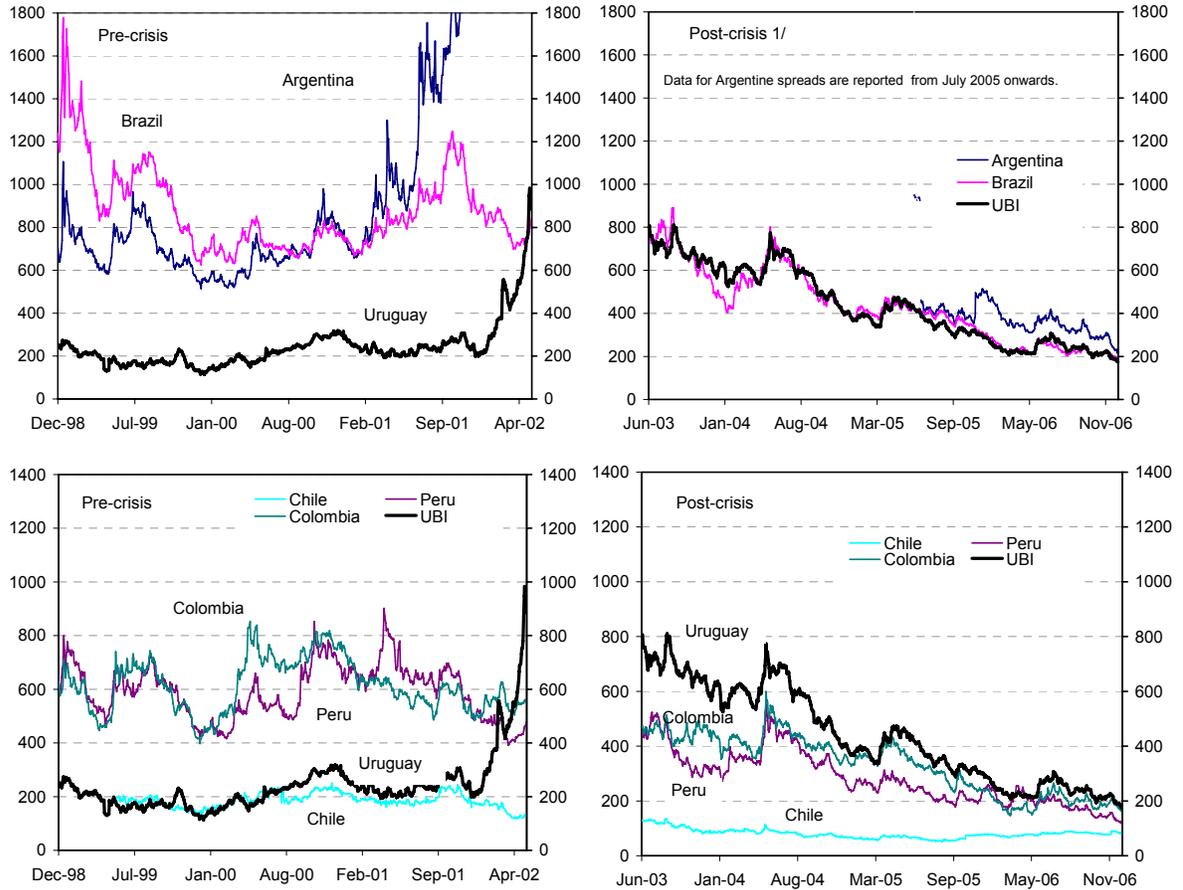


Figure 6. Uruguay and Selected Latin American country spreads, pre and post crisis.



C. What Drives Sovereign Spreads?

12. *A Vector Error Correction model (VECM) is estimated to quantify the contribution of external and domestic factors on Uruguay's sovereign spreads.* Following the methodology previously applied by Arora & Cerisola (2000) and Larzabal, Valdez and Laporta (2001) among others, the paper studies the determinants of individual country spreads. A VEC specification provides an adequate framework to disentangle short-term from long-term effects, while allowing for country-specific structural breaks.

13. *The data set comprises monthly information for 1996–2006.* Following the literature on determinants of sovereign spreads,⁹ we choose public debt, the fiscal balance, and external debt (all as share of GDP), reserve coverage (as share of short-term debt and foreign currency deposits), and the real effective exchange rate to account for country fundamentals. These fundamentals reflect the economy's repayment capacity and its vulnerability to external shocks. To capture external factors, we use U.S. interest rates, terms of trade, the high yield spread index, a market volatility measure (VIX) and EMBI spreads. As a measure of sovereign risk, we use the Uruguayan Bond Index, instead of the EMBI due to its longer time span.¹⁰ Standard unit root tests (Augmented Dickey-Fuller) confirm that all variables are nonstationary, and support the notion of first-order integration (Table 4).

Table 4. Unit Root test-Augmented Dickey-Fuller (ADF)

	In Level		First Difference	
	t-Statistic	Prob.*	t-Statistic	Prob.*
PDGDP	-1.3836	0.5888	-2.8576	0.0531
RES	-0.0800	0.9600	-11.9500	0.0034
FBGDP	-1.5654	0.4985	-14.1541	0.0000
REER	-1.9292	0.3186	-16.3656	0.0000
USTBILL	-2.8390	0.0547	-3.7968	0.0035
HY	-1.2900	0.6300	-10.9300	0.0000
VIX	-3.1592	0.0240	-10.9867	0.0000
UBI	-2.4357	0.1337	-8.5676	0.0000
EMBI	-1.6415	0.4580	-10.8208	0.0000
EMBI_LA	-2.0950	0.2500	-8.3900	0.0000

*MacKinnon (1996) one-sided p-values. Null hypothesis is unit root.

14. *A co-integrating relation is found among the Uruguayan spreads, public debt, reserve coverage, TOT, the VIX, the HY and the Latin American EMBI (Table 5).*¹¹ From all variables considered that represent country fundamentals, only the public debt-to-GDP ratio and the reserve coverage are significant in the long-run relationship.¹² They both display the expected signs. A 1 percentage point increase in the public debt-to-GDP ratio increases the spread by about 17 bps, while a 1 percentage point increase in reserve coverage reduces the spread by about 28 bps (Equation 1). Global factors, such as the ToT and the VIX enter in

⁹ For most recent work in this topic see Garcia Herrero and Ortiz (2005), Gonzalez Rozada and Levy Yeyati (2005), Jaque et al (2005), Makin and Karsten von Kleist (1999), Mauro et. al (2000), and Min (1998).

¹⁰ The UBI is built from spreads of fixed-rate, dollar-denominated Euronotes and Global Bonds issued by the Uruguayan government. UBI spreads are highly correlated with the Uruguayan EMBI spread produced by JP Morgan, since the introduction of the later in 1998.

¹¹ Both Trace and Maximum Eigenvalue tests confirm the existence of a unique co-integrating relation.

¹² External debt is excluded as it is highly collinear with the public debt-to-GDP ratio.

the long-run relationship with the Uruguayan spread, and with the right sign.¹³ It is interesting to note that, in this specification without structural break, the effect of the Latin American EMBI spread on the Uruguayan spread is not significantly different from zero. As it is shown next, this reflects the presence of a structural break.

Equation 1

$$UBI = 438.0 + 16.71 PDGDP - 27.6 RES - 8.73 TOT + 26.03 VIX + 0.02 HY - 0.13 EMBI_LA$$

(339.35) (0.76)*** (3.18)*** (3.36)** (5.80)*** (0.16) (0.15)

15. ***If a structural break is allowed, results confirm that the influence of other EMEs on Uruguay has changed following the loss of investment grade.*** Although the Latin American EMBI is not statistically significant by itself when included in the initial specification, evidence of financial spillover is found if a structural break associated with Uruguay's downgrading to speculative grade is allowed (Equation 2). Moreover, estimates show that before the crisis (and after controlling for other global financial factors) the effect of regional shocks on Uruguayan spreads was negative, suggesting that Uruguay was perceived as a safe heaven within the region.¹⁴ After the loss of investment grade, however, the effect of regional shocks on the Uruguayan spread is positive. Similar, and even stronger, results are found if the Global EMBI is used (Equation 3). While this may suggest that spillovers may stem from the emerging market asset class as a whole, it should be noted that Latin American countries (mainly Brazil and Mexico, and previously Argentina) have a significant weight in the global index.

Equation 2

$$UBI = -26.1 + 11.3 PDGDP - 15.6 RES - 6.81 TOT + 31.4 VIX + 0.37 HY - 0.33 EMBI_LA$$

(312.36) (1.16)*** (3.52)*** (3.00)** (5.24)*** (0.16)** (0.14)**

$$+ 0.49 EMBI_LA * (1 - Invgrade)$$

(0.09)***

Equation 3

$$UBI = 495.93 + 4.74 PDGDP - 18.8 RES - 5.65 TOT + 28.9 VIX + 0.25 HY - 0.49 * EMBI$$

(322.72) (1.88)** (3.54)*** (3.07)* (7.19)*** (0.15) (0.13)***

$$+ 1.14 EMBI * (1 - Invgrade)$$

(0.18)***

¹³ Unlike previous work that has stressed the effect of US interest rates on EMC spreads, this link is not found for Uruguay.

¹⁴ These results are consistent with previous work by Larzabal, Valdes and Laporta (2001) covering the pre-crisis period who find that changes in the EMBI had a negative impact on Uruguayan spreads.

16. ***While fundamentals explain part of the variance of spreads, global factors have played an important role.***

Variance decomposition analysis identifies some 20 percent of the variance explained by country fundamentals and about 60 percent by external factors.¹⁵ Among country fundamentals, public debt is most important in explaining Uruguay's spreads, and among external factors the VIX and the EMBI_LA have the largest contributions (Table 5).

Table 5. Variance Decomposition

Period	Variance Decomposition 1/							
	UBI	PDGDP	RES	TOT	VIX	HY	EMBI_LA	EMBI_LA *(1-InvGrade)
1	72.30	2.31	3.38	1.30	11.76	0.15	2.07	6.73
2	52.91	7.24	3.60	2.20	20.30	0.05	2.28	11.42
3	39.12	10.42	4.40	3.28	25.31	0.05	2.58	14.84
4	30.73	12.07	5.06	4.41	27.85	0.09	2.83	16.95
5	25.85	12.89	5.52	5.53	28.91	0.15	3.04	18.10
6	22.98	13.34	5.83	6.56	29.23	0.19	3.20	18.68
7	21.21	13.61	6.03	7.48	29.21	0.21	3.31	18.94
8	20.03	13.80	6.17	8.29	29.07	0.21	3.40	19.04
9	19.16	13.95	6.27	8.98	28.90	0.22	3.45	19.07
10	18.47	14.07	6.36	9.57	28.75	0.22	3.49	19.06

1/ Cholesky Ordering: TOT VIX HY EMBI_LA EMBI_LA*(1-INVGRADE) PDGDP RES UBI

D. Conclusions and Policy Implications

17. ***While country fundamentals have explained part of the variation in sovereign spreads, external factors have played an important role.*** External factors have become more important since the crisis, particularly after Uruguay was downgraded to speculative grade in 2002. In the late 1990s, Uruguay was largely insulated from regional and EME financial shocks, with sovereign spreads at the level of Chile's and significantly below those of non-investment grade neighbors. Since the crisis, however, Uruguayan spreads have been decoupled from those of Chile, standing at the level of—and co-moving with those of non-investment grade neighboring countries. Furthermore, after controlling for country fundamentals and global factors, econometric estimates point to heightened financial spillovers from other EMEs, following the downgrading of Uruguay's credit rating. This suggests that, following the crisis and the loss of investment grade, there has been a change in investors' perception of Uruguay's vulnerability to shocks in other EMEs.

18. ***These results suggest that, while Uruguay has made remarkable strides over the last years, it is still perceived as more vulnerable to global and regional shocks than before the crisis.*** While financial and real (trade) linkages with neighboring countries have declined in recent years, Uruguay is now more vulnerable to what happens in global markets, reflecting higher perceived riskiness. In this context, continuing to strengthen the macroeconomic framework, diversifying trade destinations, further improving the public debt structure, and implementing pending structural reforms are key towards regaining investment grade status and, thus, insulating Uruguay from a possible turnaround in global conditions and from regional shocks.

¹⁵ Based on Equation 2.

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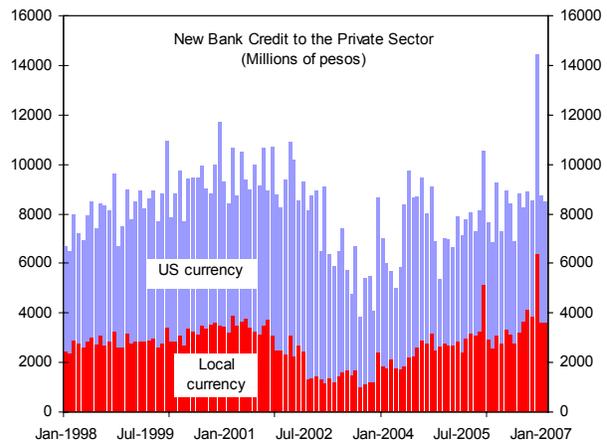
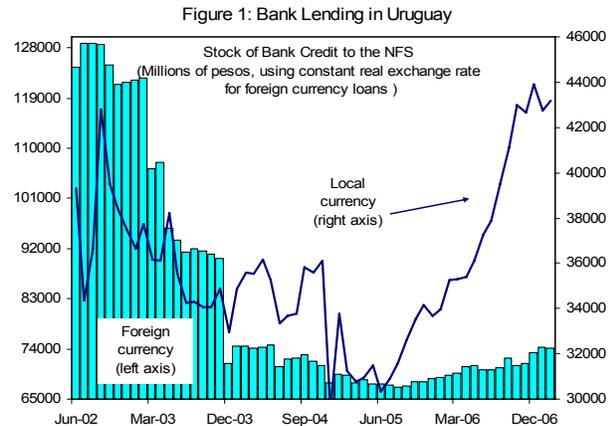
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IV. BANK-LENDING BEHAVIOR IN URUGUAY

By Gaston Gelos and Marco Piñón

A. Introduction

1. *Five years after the crisis, the first signs of a recovery in bank credit are visible (Figure 1).* In particular, lending in local currency has picked up recently. Still, lending levels remain distant from pre-crisis levels. In line with the post-crisis experience of other countries, output has so far been able to recover essentially without bank credit. However, the economy is entering in a phase where formal financial intermediation is likely to be needed to sustain growth into the medium term (Calvo, Izquierdo, and Talvi, 2005). It is therefore important to understand bank credit behavior both from a cyclical and medium-term growth perspective. What role will the new Uruguayan financial system play in the transmission of economic, including monetary, shocks? This question is particularly important given the current reassessment of the monetary policy framework in Uruguay. From a growth perspective, one relevant question is whether there are structural factors, including adequate competition, restricting financial deepening.



2. *This paper makes use of microeconomic bank data to draw inferences on bank behavior.* In addition to the usual identification problems, understanding bank behavior from a time series perspective is challenging given severe structural changes since the 2002 crisis, including the failure of various banks, the creation of a new institution, and the subsequent substantial tightening in regulation and supervision. However, using detailed monthly balance sheet data, this paper exploits its cross-sectional as well as the time-series dimension. First, the paper tests for the existence of a bank lending channel of monetary transmission for domestic currency loans. Second, it assesses whether similar effects exist for the transmission of international shocks to foreign currency loans. Third, we examine the degree of competition in the Uruguayan banking system and its evolution since the crisis.

3. *The paper finds evidence of the existence of a bank lending channel in local currency loans.* In response to a monetary contraction (expansion), banks tend to reduce (expand) their loan supply; in line with the hypothesis on the role of financial frictions, this effect is stronger for less liquid and less capitalized banks. This transmission mechanism operates above and beyond other channels, such as the interest rate or exchange-rate channel. Its quantitative significance is still somewhat limited given the preponderance of foreign-currency lending, but its importance is growing.

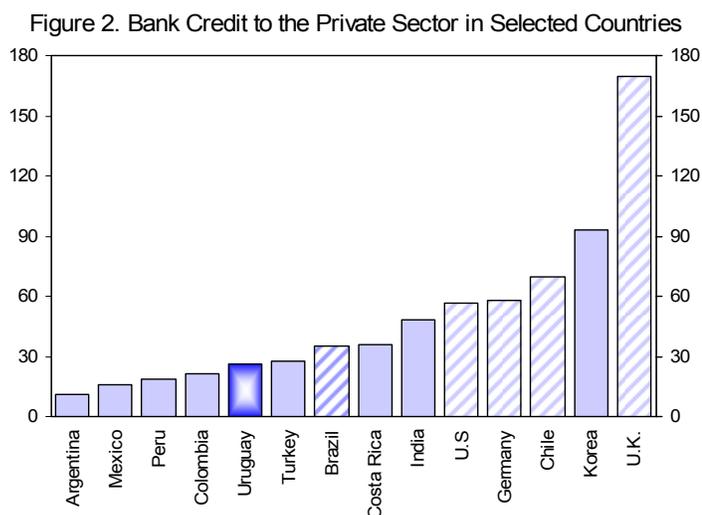
4. *Similarly, there is evidence of an equivalent transmission of foreign shocks.* More capitalized and liquid banks reduce their lending in foreign currency less strongly in response to U.S. interest hikes. There is no statistically significant difference in the reaction of banks with different degrees of liability dollarization. Together with the findings on the bank lending channel, this implies that, as bank lending picks up and bank liquidity falls, the banking system will tend to amplify domestic and foreign shocks more in the future.

5. *The banking system is characterized by relatively low competition intensity.* Some indicators suggest that competition is low relative to other countries and that it has, if anything, been decreasing. This raises the challenge of strengthening competition intensity without endangering financial stability.

B. Bank Credit in Uruguay—Background

The importance of bank lending for the Uruguayan economy

6. *Until before the crisis, credit levels relative to GDP in Uruguay were broadly in line with Latin American averages, but low by international standards.* In the 1990's, bank credit to the private sector fluctuated around 30 percent, comparable to the levels in Argentina, Brazil, and Colombia—but below OECD levels of around 70 percent (Beck and Levine, 2004) and other emerging markets. Currently, the ratio of credit to GDP in Uruguay stands at 25 percent (Figure 2).



7. *Cross country empirical evidence suggest that growth prospects in Uruguay would be enhanced through deeper financial intermediation.* A causal link from financial intermediation to growth has been empirically established in the literature. The evidence stems largely from cross-country regressions using proper instrumental variable procedures

to avoid endogeneity problems (e.g., Levine, 2004). The results indicate that financial development affects growth by increasing productivity, rather than capital accumulation (see Beck, Levine, and Loayza, 2000, and WEO (2004)). Evidence from panel regressions presented in Beck, Levine, and Loayza (2000) suggests that if bank credit in Uruguay could be exogenously raised from 30 to 35 percent, average yearly GDP growth could be 0.4 percent higher. Nevertheless, these conceptual experiments are only illustrative, with the more relevant question being how to increase financial development (Levine, 2003).

8. ***Banks have traditionally been an important source of finance for Uruguayan***

companies. The importance of stock and corporate bond markets is minimal (Table 1). In 2007, 10 companies were listed on the stock market, of which two were not traded; 23 companies were listed on the corporate bond market. In 2005, only 4 companies issued bonds. Retained earnings remains the most important source of financing for Uruguayan firms. External financing is divided up in broadly similar shares among bank loans and suppliers' credit.

Table 1. The Financing Structure of Firms in Uruguay, 2004
Structure of liabilities (percent of total)

	Bonds	Bank Loans	Suppliers' Credit	Retained earnings
Median	0	16.1	21.8	38.2
Mean	0.6	26.2	27.8	45.2

Source: de Brun et al (2006), "The fixed-income market in Uruguay."

9. ***Evidence suggests that the cyclical component of credit in Uruguay has been strongly correlated with economic activity.*** As expected, the correlation is stronger for those sectors that have less access to other sources of finance, such as households and construction (not shown). This illustrative evidence supports the notion that real activity and bank lending are linked in Uruguay; however, it does not allow to draw inferences on causality or bank lending behavior because it is unable to disentangle supply and demand effects.

Moreover, the significant structural break linked to the 2002 banking crisis, with its associated bank closures and subsequent changes in supervision, hampers the possibility of extrapolating past bank behavior to the future (Figure 3).

Figure 3. Correlations between Leads and Lags of the Cyclical Components of Credit and GDP

GDP_CY,CREDI	GDP_CY,CREDI				
T_CYC(-i)	T_CYC(+i)	i	Lag	Lead	
. ***	. ***	0	0.3066	0.3066	
. **	. ****	1	0.2382	0.4274	
. **	. ****	2	0.1583	0.4398	
. .	. *****	3	0.0453	0.4571	
. ** .	. ****	4	-0.1561	0.4127	

Sample: 1988Q1 2002Q1

Included observations: 57

Correlations are asymptotically consistent approximations.

C. The Behavior of Bank Lending: Microeconomic Evidence

Data

10. *This paper uses detailed data available on Uruguayan banks, published by the central bank of Uruguay (BCU).* The data contain monthly flow and stock variables; the paper focuses on the period 2003–06. Summary statistics are presented in Table 2. The Uruguayan banking system is characterized by a segmentation between a state bank, BROU (which represents close to 50 percent of total deposits) and a group of foreign-owned banks. The mortgage bank BHU has been banned from taking deposits and conducting lending since the crisis, and, therefore is not included in the sample.

Table 2: Selected Indicators of Uruguayan Banks by Type, 2006

	Banks	
	Private	Public (Brou)
Equity	34.2	507.7
Paid-up capital/total	4.1	0
Total assets	449.3	5,739.1
Fixed assets	5.1	155.9
Liquid assets/total assets	5.3	9.5
Loans/assets ratio	29.5	22.5
Deposits	403.4	5083
Loans/deposits ratio	32.8	25.4
Interest revenue	23.9	304.5
Interest expenses	5.9	53.2
Personnel	2	1.7
Other operating	0.9	0.6
Branches	12	119
Employment	230	3,596
Number of banks	14	1

Note: Figures are medians (in millions of U.S. dollars except for ratios, ranches, employment, and number of banks) for December, 2006. Ratios and shares are in percentage. Excludes BHU.

Is there a bank-lending channel?

11. *The bank-lending channel assigns a specific role to banks in the transmission mechanisms of monetary policy.* The basic hypothesis is that when there is a monetary contraction and banks loose deposits, financial frictions prevent banks from raising funds in an alternative manner (e.g., by issuing CDs). As a result, they reduce their lending. If firms, in turn, cannot easily substitute bank credit, this will lead to real effects.¹

12. *The paper exploits heterogeneity in bank characteristics to test for the existence of a lending channel.* Since credit aggregates are determined jointly by supply and demand, examining correlations between credit and other economic variables does not identify a lending channel. Therefore, the strategy adopted in this literature is to focus on cross-sectional differences in bank behavior: banks that can *a priori* be expected to be less credit constrained should react less strongly to monetary policy shocks (see, for example, Kashyap and Stein, 2000). This paper differentiates banks according to their degree of liquidity and capitalization. It is presumed that firms cannot easily substitute bank loans with other sources of external finance, in light of the evidence presented earlier.

13. *Loan growth regressions are estimated using quarterly data with short-term interest rates and changes in the announced growth rate of M0/M1 as monetary policy variables.*

¹ See Bernanke and Blinder (1998) and Bernanke and Gertler (1992). The bank lending channel hypothesis is a specific mechanism within the broader “credit channel hypothesis.” The latter states that due to financial frictions, monetary policy affects the external finance premium that firms and banks have to pay to borrow.

To obtain a measure of truly exogenous monetary policy shocks, the paper first regresses the change in each of these domestic monetary variables on changes in U.S. interest rates and Latin American EMBI spreads and then use the predicted values of these regressions.

Dynamic regressions are estimated using manufacturing growth, exchange rate change, the change in country risk, and the change in inflation expectations as control variables. Time dummies are also used as alternatives. The estimations are carried out with bank dummies, allowing for bank-specific heterogeneity, for correlation of contemporaneous errors, and correcting for first-order serial correlation.²

$$(1) \Delta \log(Loans_{it}) = \sum_{j=1}^m a_j \Delta \log(Loans_{it-j}) + \sum_{j=0}^m b_j \Delta MonetaryVariable_j + \sum_{j=0}^m c_j \Delta MonetaryVariable_j \cdot BankChar_{it} + d \cdot BankChar_{it-1} + \sum_{j=0}^m e_j \Delta ControlVar_j + \mu_i + \varepsilon_{it}$$

14. ***The results support the existence of a bank-lending channel for local currency loans.***

In line with the hypothesis, it is found that more liquid and more capitalized banks do react less strongly to monetary policy shocks (Table 3). For example, a 1 percent increase in the short-term interest rate yields an average drop in the quarterly growth rate in local currency credit of about 2 percent (compared to a median growth rate of 5 percent in the sample). A bank at the top 80 percentile liquidity ratio, however, would significantly change its lending. As expected, the bank-lending channel effects cannot be confirmed statistically for overall loans, given the large share of dollar loans. With the share of peso credit growing, the bank-lending channel will be gaining quantitative importance in Uruguay.

Table 3. Differential Response of Local Currency Loan Growth to Monetary Policy Shocks by Bank Characteristic

Monetary Policy Variable	Differential Impact by Bank Characteristic	
	Liquidity	Capitalization
Δi	-0.015***	-0.024**
$\Delta i \times$ Bank characteristic	0.0015***	1.094***
ΔM	0.244***	0.0932
$\Delta M \times$ Bank characteristic	-0.003***	-1.604***

Estimation period: 2003:Q1-2006:Q4. Quarterly data, two lags. Long-term coefficients are reported. Based on GLS estimation with bank fixed effects and time effects, allowing for correlation of errors and correcting for serial correlation. Control variables manufacturing growth, exchange rate change, change in country risk, change in inflation expectations. Does not include BROU (including BROU yields similar results). Δi and ΔM , (predicted) refers to the fitted values of a regression of domestic interest changes on the Latin EMBI spread and U.S. interest rates.

15. ***A growing importance of the bank-lending channel brings opportunities and challenges.*** While the effectiveness of monetary policy is enhanced through this additional mechanism, the amplification of monetary shocks implies the need for a more fine-tuned policy. Moreover, as banks continue to lend more, their current high liquidity levels are likely to fall, further amplifying their responses.

² Given the presence of a lagged dependent variable, GMM estimation could have followed Arellano and Bond (1991) or Arellano and Bover (1995). We did not pursue this here because the cross-sectional dimension of the panel is small; moreover, we were not interested in the coefficient on the dependent variable.

The transmission of foreign shocks

16. ***Does a similar mechanism operate in the transmission of foreign shocks?*** To answer this question, the paper explores a similar specification with a focus on the transmission of foreign shocks. In particular, it examines the effects of changes of U.S. interest rates on foreign currency lending behavior, by type of bank.

17. ***More liquid banks and with fewer dollar liabilities reduce their lending less strongly in response to U.S. interest***

hikes. An increase in U.S. interest rates is associated with a drop in lending—a 100 basis points increase yields a drop in the quarterly growth rate of 9 percentage points (Table 4). This effect is milder for more liquid and better capitalized banks.

There is no statistically significant difference in the reaction of banks with different degrees of capitalization.

Table 4. Differential Response of Foreign Currency Loan Growth to Foreign Shocks

Foreign Shock	Differential Impact by Bank Characteristic		
	Liabilities	Liquidity	Capitalization
Δi US	-0.09***	-0.12***	-0.06***
Δi US x Bank Char	-0.34***	0.002***	-0.154

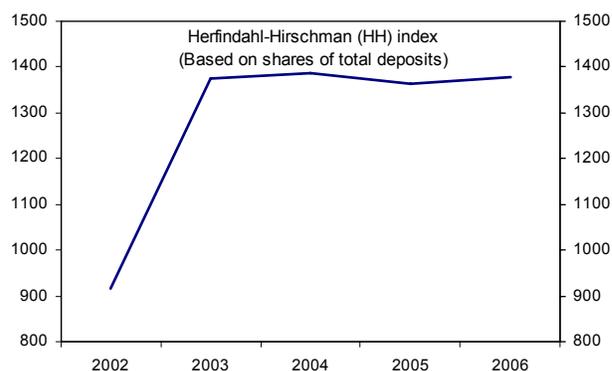
Estimation period: 2003:Q1-2006:Q4. Quarterly data, two lags. Long-term coefficients are reported. Based on GLS estimation with bank fixed effects and time effects, allowing for correlation of errors and correcting for serial correlation. Control variables. Includes BROU.

D. What is the Degree of Competition Intensity in the Uruguayan Banking System?

18. ***To assess prospects for increased financial intermediation the paper examines competitive conditions in the banking sector.*** International evidence shows that higher banking competition is associated with lower spreads and easier access to finance by companies (Gelos, 2006 and Beck, Demirguc-Kunt, and Maksimovic, 2004). The degree of competition may also matter from a cyclical perspective, as it has been argued that imperfect competition in the banking sector may propagate external shocks and amplify swings (Mandelman, 2006).³

19. ***Concentration in the Uruguayan banking system has risen.*** The number of banks has declined during and after the crisis, and the market concentration has increased, as measured by Herfindahl-Hirschman (HH) indices (Figure 4). The index is now close to 1400. As a comparison, Gelos and Roldos (2002) report HH indices for 13 emerging markets; in their sample, the median HH index in 2000 was 900, and the median in Latin America 923.

Figure 4: Concentration Index



³ Regarding the relationship between competition and financial stability, the evidence is not conclusive (see for example the discussion in Drummond, Maechler, and Marcelino, 2007).

20. *The paper uses a market structure test based on reduced form revenue functions suggested by Panzar and Rosse (1987).* Panzar and Rosse show that the sum of the elasticities of a firm's revenue with respect to the firm's

input prices (the so-called H statistic) can be used to identify the nature of the market structure in which the firm operates. In long-run competitive equilibrium, the H statistic should be equal to one, as increases in input prices should lead to a one-to-one increase in total revenues. By contrast, the H will be negative if the firm operates as a monopoly—an upward shift in the marginal cost curve will be associated with a reduction in revenue as a result of the optimality condition for the monopolist (Table 5). Under monopolistic competition, the H statistic will lie between zero and one. If the elasticity of demand is constant, then there is a monotone relationship between the mark-up over marginal costs—a measure of the degree of competition—and the H index. More formally, letting R denote a revenue function of input prices w and exogenous variables z :

$$R = R(w, z)$$

$$H = \sum_i \frac{\partial R^*}{\partial w_i} \frac{w_i}{R_i}$$

21. *The paper treats banks as single product firms (De Bandt and Davis, 2000);* banks produce intermediation services using labor and capital as inputs.^{4,5} The Panzar and Rosse (1987) approach has been applied widely to banking systems. Early studies examine competitive conditions in the U.S. and Canada (see Shaffer (1989) and Nathan and Neave (1989)), respectively.⁶

22. *To derive the H statistic, the paper estimates the following reduced form revenue equation:*

$$(2) \quad \ln IR = c + a \cdot \ln w_L + b \cdot \ln w_F + c \cdot \ln w_K + d \cdot cap + e \cdot oth$$

⁴ However, product differentiation is allowed for in the monopolistic competition model.

⁵ See Freixas and Rochet (1997).

⁶ For studies of European countries, see Molyneux, Lloyd-Williams, and Thornton (1994), Bikker and Groeneveld, (2000), and De Bandt and Davies, (2000). For a study covering various emerging markets see Gelos and Roldós (2003). Individual country studies include, among others, Austria (Mooslechner and Schnitzer, 1995), Brazil (Belaisch, 2003), Bulgaria (Feyzioğlu and Gelos, 2000), Colombia (Barajas, Steiner, and Salazar), Italy (Coccorese, 1998), Switzerland (Rime, 1999), Germany (Lang, 1997, and Hempell, 2002), Japan (Molyneux, Lloyd-Williams, and Thornton, 1996), and Finland (Vesala, 1995).

Table 5. Panzar and Rosse's H Statistic

Market structure	
$H < 0$	Monopoly [or conjectural variation oligopoly]
$0 < H < 1$	Monopolistic competition
$H = 1$	Perfect competition or monopoly in a perfectly

where

IR	=	interest revenue (or interest revenue divided by total assets)
C	=	constant
w _L	=	unit price of labor
w _F	=	unit price of funds
w _K	=	unit price of capital
cap	=	capacity indicators, such as total fixed assets
oth	=	other factors potentially affecting interest revenues, such as the business mix of the bank, and the size of total assets (to control for scale effects), and nonperforming loans

23. ***Equation (2) is estimated using semiannual data for 2003–06.*** The unit cost of labor is proxied by salary expenses over personnel, the unit cost of funds by interest payments over deposits, and the unit cost of capital by other expenses divided by total fixed assets. The paper also tests for changes in the H statistic between 2003–04 and 2005–06 (Table 6).

24. ***The estimates suggest that the banking system is characterized by monopolistic competition.*** With the H statistic around 0.5, the estimation indicates that the degree of competition intensity is low by international standards. In a study comprising 50 countries, Claessens and Laeven (2004) report H statistics around 0.6–0.8, with a median value close to 0.7. Although cross country comparisons of these statistics are problematic, the finding of low competition confirms Mello’s (2006) results, who uses a different approach and does not look at changes over time. A caveat is that the standard errors are large, so that the measurement is not very precise.

25. ***Along with the rise in concentration, competition has tended to decrease since the crisis.*** The estimates show a drop in H since 2005, albeit only at low significance levels. Nevertheless, the more recent estimates may be more valid since the banking system is likely to be operating under conditions more closely resembling those of a long-run equilibrium.

26. ***The results suggest that increasing competition in the banking system without jeopardizing financial stability is an important challenge for Uruguay.*** While a discussion of concrete policy measures in this area would exceed the scope of the paper, leveling the playing field between private and public banks would likely contribute to this objective (see Mello, 2006, and IMF, 2006).

Table 6. Results from Revenue Estimations

	(1)	(2)	(3)	(4)
	lnir	lnrev	lnir	lnrev
Ln (wages)	0.269 (2.17)*	0.265 (2.00)*	0.269 (2.15)*	0.267 (2.00)*
Ln (cost of funds)	0.252 (3.48)**	0.233 (3.41)**	0.250 (3.45)**	0.232 (3.39)**
Lnw (cost of capital)	0.260 (3.58)***	0.230 (3.21)**	0.259 (3.04)**	0.224 (2.57)**
Ln (wages) x after	-0.038 (0.85)	-0.038 (0.96)	-0.039 (0.84)	-0.039 (0.96)
Ln (cost of capital) x after	-0.193 (3.07)**	-0.186 (3.20)**	-0.193 (3.04)**	-0.188 (3.15)**
Ln (cost of funds) x after	-0.023 (0.43)	-0.021 (0.48)	-0.023 (0.43)	-0.022 (0.48)
Loans/Total assets	1.404 (3.91)***	1.318 (3.94)***	1.434 (3.98)***	1.344 (4.00)***
Ln (total assets)	0.977 (8.67)***	1.065 (9.79)***	0.972 (8.67)***	1.062 (9.76)***
No. of Obs.	88	88	84	84
R-squared	0.98	0.98	0.97	0.97
H 2003-04	0.78	0.73	0.78	0.72
Change in H	-0.25*	-0.25*	-0.25	-0.25*
H 2005-05	0.53	0.48	0.52	0.47

After=Dummy for period since 2005. Include bank fixed effects. Standard errors are adjusted for clustering by date.

* Denotes significant at the 10 percent confidence level; ** significant at 5 percent; *** significant at 1 percent.

E. Conclusions

27. *This paper assessed the role of and prospects for bank-lending in Uruguay from a cyclical and structural perspectives.* Specifically, the paper tested the existence of bank-lending-channel transmission mechanisms in response to domestic and external shocks for local and foreign currency credit. It also looked at the competitive structure of the domestic banking system.

28. *The results indicate that bank-lending in local currency reacts to changes in domestic policies.* This suggests that monetary policy will become more effective over time, but also more challenging. With a growing share of peso-denominated debt, the bank-lending channel will be becoming more important. This means that monetary policy shocks will be amplified, which in turn implies that its fine-tuning will become more relevant.

29. *The results also show that domestic credit in foreign currency is partly driven by foreign shocks.* Moreover, the less liquid banks are, the more foreign and domestic shocks

are amplified. With the ongoing resumption in lending, banks' liquidity will naturally decline from their current high levels. This will further amplify the effect of shocks in the future, implying the need for more vigilance in macroeconomic policies.

30. ***From a structural perspective, the study indicates that measures to promote a more competitive environment are likely to enhance sustained growth over the medium term.*** In particular, it finds that the degree of competition in the Uruguayan banking system is relatively low by international standards. Looking ahead, this may limit financial deepening and, thereby, economic growth. Thus, a challenge for the authorities is to further foster healthy competition while preserving the soundness of the financial system.

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V. THE OPTIMAL LEVEL OF RESERVES IN FINANCIALLY DOLLARIZED ECONOMIES: THE CASE OF URUGUAY

By Fernando M. Gonçalves

A. Introduction

1. *The recent increase in holdings of foreign reserves in many countries has renewed the interest in assessing the motives and adequacy of reserve accumulation.* Because reserves provide protection against external shocks but are costly to carry, a careful assessment of the adequacy of reserve levels is warranted.

2. *One frequently cited motive for holding large amounts of foreign reserves is to self-insure against costly crises.*¹ Reserves can be useful for mitigating the fall in domestic consumption that may result from a sudden stop of external credit and/or a run on banks' foreign currency deposits. Such insurance role of reserves is more pronounced in dollarized economies, where financial account reversals and bank runs typically have larger adverse effects because of currency mismatches in the balance sheets of economic agents.²

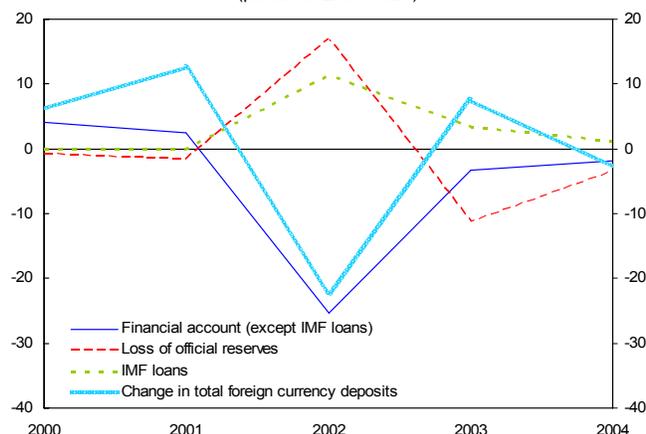
3. *Foreign reserves played a significant role in mitigating the effects of the 2002 crisis in Uruguay.*

Following the Argentine crisis in 2001, Uruguay experienced a sudden stop of external credit and a banking crisis.³

Figure 1 shows the resulting large financial account reversal and withdrawal of dollar deposits. It also depicts the large amount of reserves—a significant part of which made available through an IMF arrangement—used to offset the outflows. While output

dropped significantly, the use of reserves helped offset a potentially much larger fall in economic activity.

Figure 1. Financial Account Reversal, dollar deposits and reserves in Uruguay (percent of 2001's GDP)



¹ Countries may accumulate reserves to achieve a range of objectives, not restricted to self-insurance. Other possibilities include: (i) making exchange rate markets more efficient by providing liquidity when needed; (ii) limiting exchange rate volatility (“leaning against the wind”); and (iii) pursuing, even if temporarily, export-led growth supported by a de facto fixed exchange rate (see Becker et al., 2007, and European Central Bank, 2006).

² For an analysis of balance sheet mismatches in Uruguay, see Kamil (2006).

³ See De la Plaza and Sirtaine (2005) for a detailed analysis of the 2002 crisis in Uruguay.

4. *This chapter assesses the adequacy of foreign reserves in Uruguay from a prudential perspective.* The framework derived by Jeanne and Rancière (2006) (henceforth, JR) is extended to explicitly incorporate the dollarization of bank deposits. The paper illustrates the relevance of this extension by calibrating the model for Uruguay, a highly dollarized country in which higher reserve levels are valuable for prudential reasons, even though short-term foreign currency debt is low.

B. Vulnerabilities and the Role of Reserves in Uruguay

5. *Short-term foreign currency debt is now at historically low levels.*⁴ While in 2002 short-term foreign currency indebtedness of public and private sectors was over 40 percent of GDP, by end-2006 it had fallen to less than 3 percent of GDP (Figure 2).

6. *Despite significant progress, high deposit dollarization and nonresidents' deposits remain important sources of vulnerability.* As illustrated by the 2002 crisis experience, nonresidents' deposits are more susceptible to large withdrawals than residents' (Figure 3). In recent years, nonresidents' foreign currency deposits have decreased sharply, reaching 9 percent of GDP at end-2006, thus representing a significant reduction in banking sector vulnerability. Nonetheless, foreign currency deposits remained at the high level of about 37 percent of GDP in end-2006. Thus, while risks have been reduced considerably since the crisis, dollarization of deposits remains one of the highest in the world and a major vulnerability for the Uruguayan economy.

Figure 2. Short-term foreign currency debt and foreign currency deposits in Uruguay (percent of GDP)

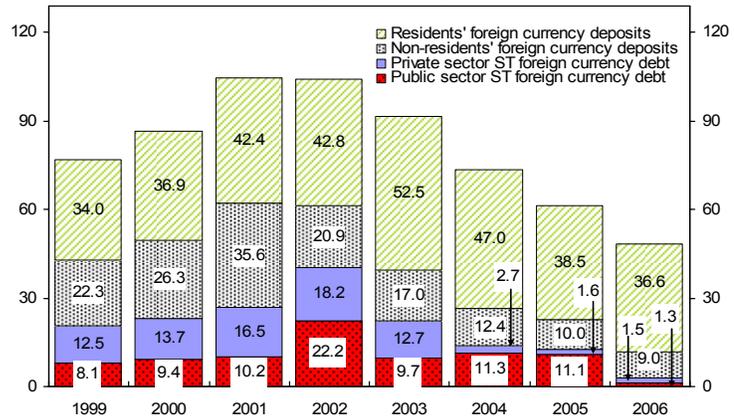
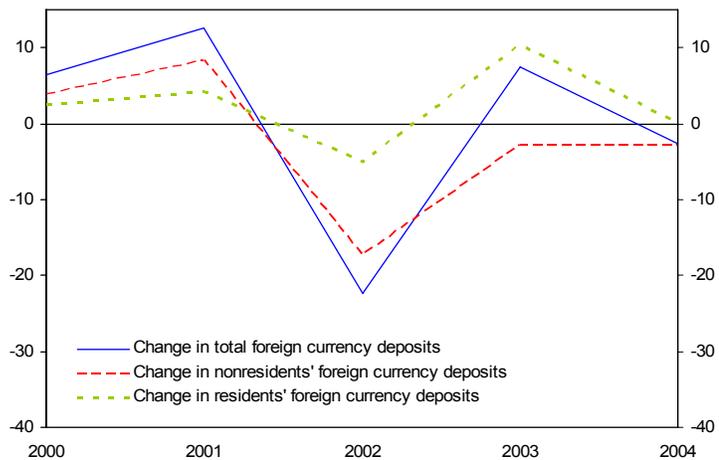


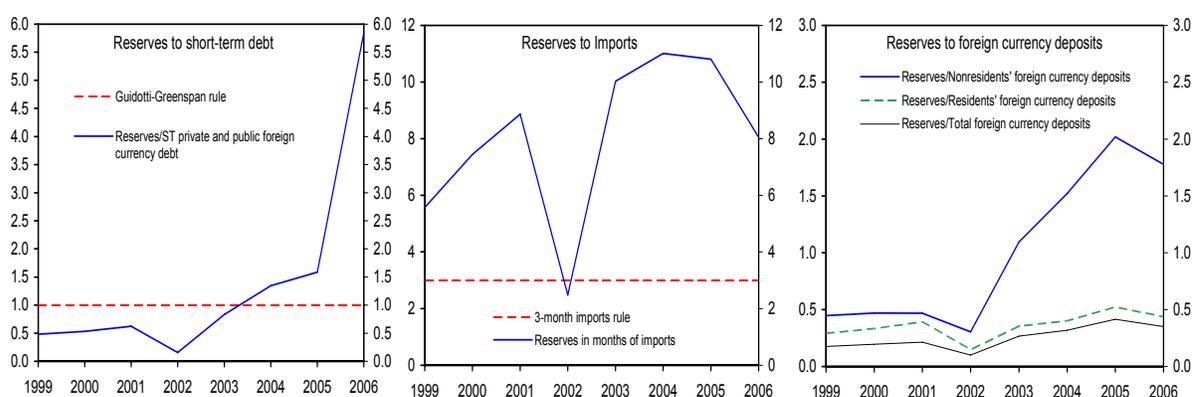
Figure 3. Withdrawal of foreign currency deposits in 2002 (percent of 2001's GDP)



⁴ The definition of public and private short-term debt is in a remaining maturity basis. Public sector short-term foreign currency debt includes both domestic and external debt.

7. **Reserve adequacy measures should take into account the degree of deposit dollarization.**⁵ Traditional measures would suggest that Uruguay holds comfortable reserve levels (Figure 4). Reserves are now well above all short term foreign currency debt (Guidotti-Greenspan rule), in contrast to the years prior to the 2002 crisis. Also, coverage of imports has consistently exceeded 3 months, except in the year of the crisis. The Uruguayan economy was particularly vulnerable to a bank run prior to the 2002 crisis: reserves covered only 18 percent of dollar deposits. Reserve coverage of dollar deposits has increased substantially since then to about 35 percent (more than 100 percent of nonresidents' deposits). However, further analysis is needed to establish whether reserves now provide an appropriate balance between costs and protection against a major withdrawal of dollar deposits.

Figure 4. Benchmark Measures of Reserve Adequacy



Source: International Financial Statistics; Central Bank of Uruguay; and author's calculations.

C. The Optimal Level of Reserves

8. **What is the optimal level of foreign reserves for self-insurance purposes in a financially dollarized economy?** To address this question, JR's model is extended to explicitly take into account dollar-denominated deposits. The resulting expression for the optimal level of reserves is shown in equation (1) below (a full derivation of the model is in Appendix 1). It includes parameters computed from actual data (Table 1) and also parameters that need to be calibrated and are assumed fixed during the sample period (Table 2).

9. **The formula balances the consumption-smoothing benefits with the quasi-fiscal costs of holding reserves.** It states that optimal reserves are increasing in the magnitude of deposit withdrawals ($\phi\lambda_D$), private (λ_p) and public (λ_G) short-term foreign currency debt, output cost (γ) and the likelihood of a crisis (π). Intuitively, reserves are more useful as a buffer the larger the drop in consumption (caused by the withdrawal of dollar deposits and sudden stop in foreign currency credit) and the bigger the probability of such drop. A larger

⁵ See Wijnholds et al. (2001) for a discussion of traditional benchmark measures of reserve adequacy.

coverage of dollar deposits by banks' own reserve holdings (i.e., by banks' liquid foreign assets⁶— $\alpha\lambda_D$) implies less optimal (official) reserves, as such coverage also provides cushion to dollar deposits withdrawals in a crisis. In addition, a real exchange rate depreciation (Δq) increases the burden of foreign currency liabilities, leading to further drops in consumption and, thus, larger optimal reserves. Finally, the optimal level of reserves is decreasing in the cost of holding reserves, which is captured by the interest rate differential between long-term debt issued to finance reserves and the return on reserves (δ).

$$(1) \quad \rho = \lambda + \gamma + \frac{(1-\gamma)p^{1/\sigma}\Delta q}{1+[p^{1/\sigma}(1+\Delta q)-1](1-\pi-\delta)}$$

$$- \frac{p^{1/\sigma}(1+\Delta q)-1}{1+[p^{1/\sigma}(1+\Delta q)-1](1-\pi-\delta)} \left\{ 1 - \frac{r-g}{1+g} (\lambda + (1-\phi)\lambda_D) - (\pi + \delta)(\lambda + \gamma) \right\},$$

where $\lambda = (\phi - \alpha)\lambda_D + \lambda_p + \lambda_G$, $\phi = s_R C_R + s_{NR} C_{NR}$, and $p = \frac{(1-\pi)(\delta + \pi)}{\pi(1-\delta-\pi)(1+\Delta q)}$.

10. ***In a crisis, the percentage drop in nonresidents' deposits tend to be larger than the percentage drop in residents' deposits.*** While the ratio of liquid foreign assets of banks to foreign currency deposits has been relatively stable in Uruguay, the composition of foreign currency deposits has shifted from nonresidents to residents in recent years. Because, in the event of a crisis, the percentage drop in nonresidents' deposits is typically larger than for residents' deposits, the current coverage of deposits by banks' liquid foreign assets can be considered stronger than in 2002. In order to reflect this in the calibration, the ratio of banks' liquid foreign assets to dollar deposits is corrected to control for the change in residents/nonresidents composition of deposits over time.⁷

⁶ Banks' liquid foreign currency assets comprise cash, bonds and deposits with maturity of less than one year in a remaining maturity basis.

⁷ In the model, α is defined as the ratio of banks' liquid foreign assets (BLFA) to total dollar deposits

(residents – R – and nonresidents – NR), $\alpha = \frac{BLFA}{R + NR}$. Note that α can be rewritten as follows:

$$\alpha = \frac{BLFA}{R + NR} = \frac{BLFA}{NR} \times \frac{NR}{R + NR}$$

The first term, the coverage of nonresidents' deposits by banks' liquid

foreign assets, has increased since the 2002 crisis, while the second term, the share of nonresidents' deposits, has decreased. The reduction of the latter term implies a reduction in the risk of large deposit withdrawals. For comparability purposes, it is sensible to maintain the same "level of risk" in all years of the sample. This is done by assuming that in previous years the composition of residents'/nonresidents' deposits was the same as in

2006, yielding the corrected measure $\alpha_y^C = \frac{BLFA}{R + NR} = \left(\frac{BLFA}{NR} \right)_y \times \left(\frac{NR}{R + NR} \right)_{2006}$, where y is the year

under consideration.

Table 1. Variable Parameters
(In percent)

	1999	2000	2001	2002	2003	2004	2005	2006
Public sector short-term foreign currency debt/GDP (λ_G)	8.1	9.4	10.2	22.2	9.7	11.3	11.1	1.3
Private sector short-term foreign currency debt/GDP (λ_P)	12.5	13.7	16.5	18.2	12.7	2.7	1.6	1.5
Total foreign currency deposits/GDP (λ_D)	56.3	63.3	78.0	63.7	69.4	59.4	48.5	45.7
Non-residents' foreign currency deposits/ Total foreign currency deposits (S_{NR})	39.6	41.6	45.6	32.8	24.4	20.9	20.6	19.8
Residents' foreign currency deposits/ Total foreign currency deposits (S_R)	60.4	58.4	54.4	67.2	75.6	79.1	79.4	80.2
Banks' liquid foreign assets as a share of foreign currency deposits—corrected (α^C)	16.2	17.3	13.9	21.4	28.9	41.0	42.8	37.3

11. **Many of the parameters are calibrated following standard conventions.** The risk aversion parameter is set at 2, a number typically used in the business cycle literature. The risk free short-term dollar interest rate (the return of reserves) is set to 5 percent, about the average U.S. 3-month T-bill rates in the last 10 years. The term premium is assumed to be 1.5 percent, close to the average difference between the yield on 10-year U.S. treasury bonds and the federal fund rate in the last 20 years. The growth of potential output in Uruguay is calibrated at 3 percent. The real exchange rate depreciation following a crisis is calibrated at 30 percent, slightly less than the 33 percent depreciation that took place between March and September of 2002.

12. **Coverage of foreign currency deposits by official reserves and banks' liquid foreign assets was set at 100 percent for nonresidents and 30 percent for residents.** The full coverage for nonresidents deposits, which broadly matches the current practice by banks in Uruguay, would insulate the domestic economy from sudden withdrawals by nonresidents, that can be large as evidenced by the 2002 crisis. Since residents' deposits are less volatile than nonresidents,' a smaller coverage of 30 percent seems appropriate.

13. **The output loss due to a crisis was calibrated at 7 percent of GDP per year during 2 years.** The accumulated output loss of the Uruguayan economy as a result of the 2002 crisis was about 18.5 percent, and output took roughly two years to recover to its pre-crisis levels. Given the improved external conditions, compared with 2002 (when the devaluation in Brazil

Table 2. Fixed Parameters

Coverage of non-residents' deposits (C_{NR})	100%
Coverage of residents' deposits (C_R)	30%
Accumulated output loss (γ)	14%
Probability of sudden stop (π)	7.5%
Term premium (δ)	1.5%
Risk-free rate (r)	5%
Risk aversion (σ)	2
Real exchange rate depreciation (Δq)	30%
Long-run GDP growth rate (g)	3%

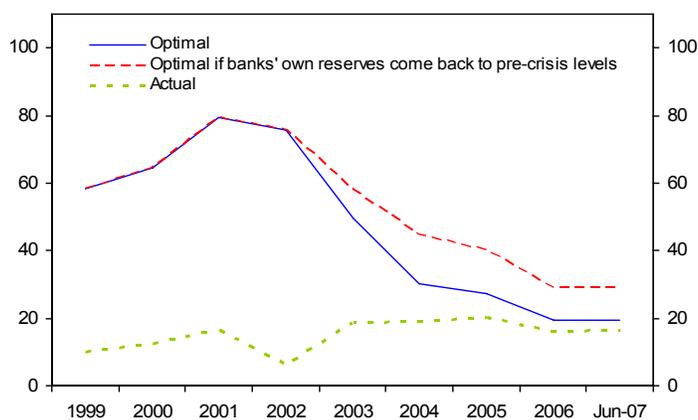
was followed by a severe crisis in Argentina), we assumed a smaller output loss (14 percent). This is also close to estimates found in the literature on currency crisis and sudden stops for a typical emerging market country.⁸

14. ***The probability of a crisis was calibrated at 7.5 percent a year, or an average of one crisis every 15 years.*** JR's estimation, based on a cross-country Probit model, yields a probability of 10 percent for a typical emerging market country. Nonetheless, Uruguay track record of one major crisis every 20 years (1982 and 2002) implies an observed crises frequency of 5 percent. Given the potential specification problems of the Probit estimation and the difficulty of inferring the probability from Uruguay's few crisis episodes, the calibration is set to the intermediate probability of 7.5 percent.

15. ***As vulnerabilities have diminished since 2002, so has the estimated optimal level of reserves.***

Because short-term foreign currency indebtedness and deposit dollarization have been decreasing since 2002 and given the exceptionally high banks' liquidity levels, the need for central bank reserves for prudential purposes has diminished (Figure 5). Prior to the crisis, the estimated optimal level of reserves reached almost 80 percent of GDP in 2001 (or US\$14.7 billion), highlighting the large vulnerabilities of the economy at the time. In June 2007, with less vulnerabilities, the optimal level of central bank reserves was estimated to be less than 20 percent of GDP (or around US\$3.8 billion). That is about 1.7 percent of GDP (or US\$300 million) above current levels.⁹

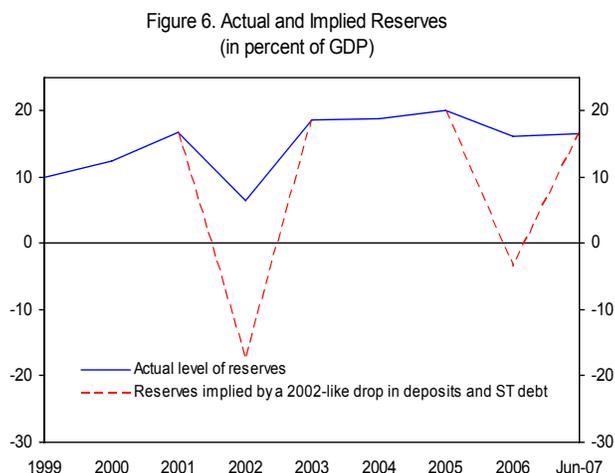
Figure 5. Optimal versus actual level of reserves in Uruguay (in percent of GDP)



⁸ Hutchison and Noy (2006) find that the cumulative output loss of a sudden stop (defined as a simultaneous occurrence of a currency/balance-of-payments crisis with a reversal in capital inflows) is around 13–15 percent of GDP.

⁹ The definition of the actual level of reserves excludes an account of the government in the central bank that has liquid foreign assets. While the value of assets in this account can be very large, it is also very volatile (in end-2005 it had US\$328 million, then in end-2006 the account had zero assets, and in June 2007 it had US\$1.2 billion) and is not included in official reserve figures since it is typically held by the government momentarily and used for debt management purposes, not as precautionary reserves.

16. ***Simulations indicate that reserves are close to adequate levels and would be nearly sufficient to deal with a 2002 like crisis.***¹⁰ This is a consequence of increased reserves and, more importantly, reduced vulnerabilities. Figure 6 simulates the results of a 2002-like crisis, i.e. drops in nonresidents' and residents' deposits, and short term debt of 63 percent, 36 percent, and 26 percent respectively. While such drops generated a severe reserve gap in 2002 in the absence of external support, a similar scenario in 2006 yields a much smaller gap.



17. ***However, further accumulation is still desirable.*** In particular, the optimal level of central bank reserves is likely to increase in the next few years, as the ongoing credit recovery matures and banks' reduce their currently high holdings of liquid external assets. As an illustration of a relatively extreme scenario, Figure 5 shows that the optimal level of reserves as of June 2007 would increase to 28.9 percent of GDP (or about US\$5.7 billion) if banks' coverage of deposits by own foreign liquid assets returned to pre-crisis levels.¹¹ This highlights the importance of proper banking regulation that addresses the vulnerabilities caused by dollar deposits, thereby limiting the need for central bank reserve accumulation.

D. Sensitivity Analysis

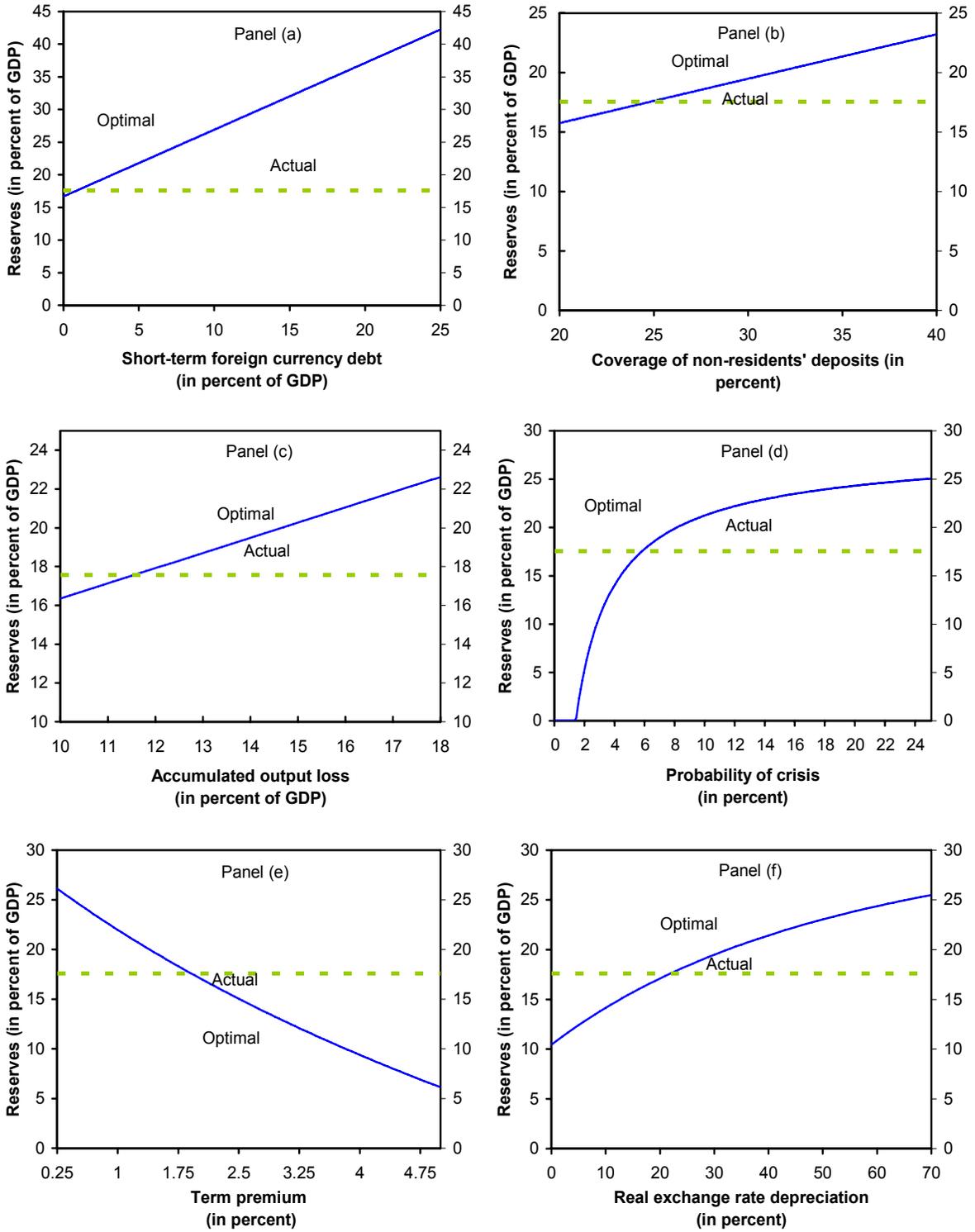
18. ***The optimal level of reserves is very sensitive to calibration choices.*** Thus, undertaking a sensitivity analysis is important to gain broader perspective on the results under different conditions or parameter values. Figure 7 focuses on those parameters that, if changed, most affect the optimal level of reserves. The following facts emerge:

- (i) an increase in short-term foreign currency debt to 25 percent of GDP (a level close to 2001's), would result in an optimal level of reserves of over 40 percent of GDP;
- (ii) coverage of residents' deposits in the range 10–40 percent would imply reserve levels between 15–25 percent of GDP;
- (iii) an output loss of the magnitude observed in 2002 (about 18.5 percent of GDP) would imply an optimal level of reserves of over 22 percent of GDP;
- (iv) JR's calibration of a 10 percent probability of a crisis would yield an optimal level of reserves of 21 percent of GDP;
- (v) an increase in the term premium from 1.5 to 2.5 percent would raise the cost of holding reserves, and would lead to a sharp drop in the optimal level

¹⁰ See Appendix 2 for an explanation on how simulation results were obtained.

¹¹ The dashed line in Figure 5 assumes that the corrected ratio of banks' liquid assets to deposits is at pre-crisis level (the later is obtained by the 1999–2001 average of the ratio of banks' liquid assets to deposits).

Figure 7. Sensitivity Analysis



Source: Author's calculations

of reserves (more than 4 percent of GDP); and (vi) a real exchange rate depreciation between 0–70 percent results in optimal reserve levels between 10–25 percent of GDP.

19. ***The current reserve levels***

would be optimal under certain

assumptions. For example, if the parameter on coverage of residents' foreign currency deposits were reduced from 30 percent to 25 percent of deposits, the model would suggest

optimal reserves roughly in line with existing levels. An accumulated output

loss of 11–12 percent (much smaller than 2002's experience), or a probability of crisis just below 6 percent would yield similar results. Finally, a term premium of 2 percent (significantly higher than historical averages), or a real exchange rate depreciation in a crisis of about 22 percent (much smaller than observed in the last crisis), would also imply that the current reserve level is optimal (Table 3).

Table 3. Implicit Parameters
(In percent)

Short-term foreign currency debt/GDP ($\lambda_G + \lambda_P$)	0.9
Coverage of residents' deposits (C_R)	24.8
Accumulated output loss (γ)	11.6
Probability of sudden stop (π)	5.8
Term premium (δ)	2.0
Real exchange rate depreciation (Δq)	21.8

E. Conclusions

20. ***A model calibrated for Uruguay, a financially dollarized economy, suggests that reserves are nearing optimal prudential levels.*** The model takes into account the risk of financial account reversals typically analyzed in these studies and the possibility of large withdrawals of foreign currency deposits in the event of a crisis. With the substantial decline of nonresidents' deposits and short-term foreign currency debt since the 2002 crisis, and the high holdings of liquid foreign currency assets by banks, the prudential benefit of holding official reserves has diminished. In the model, this is reflected in a significant drop of the optimal level of reserves since 2002 which, together with the accumulation of reserves by the central bank, has nearly closed the gap between the optimal and the actual reserve levels.

21. ***Nonetheless, there are several reasons that justify further reserve accumulation.*** In particular, with banks' currently high liquidity levels unlikely to be permanent, the optimal level of official reserves should increase in the years ahead. Also, sensitivity analysis shows that an increase in short-term foreign currency indebtedness, among other possible changes in economic conditions, would lead to a large increase of the optimal level of reserves. In addition, with the model focusing on crisis mitigation (rather than crisis prevention), the calculated optimal level of reserves could be seen as a lower bound. By assuming a crisis probability independent of reserves, the model did not capture a possible preventive role of reserves.¹² Adding this role would provide another reason to hold reserves, most likely leading to an increase in the model predictions about optimal reserve levels.

¹² See Garcia and Soto (2006), Jeanne (2007), and Chami et al. (2007).

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Appendix 1. A Model of Optimal Reserve Levels in Financially Dollarized Economies

Consider a small open economy in discrete time which may be hit by a ‘sudden stop’, defined as an exogenous loss of external credit. When a sudden stop hits the economy, (1) short-term external debt is not rolled over; (2) a significant fraction of foreign currency deposits is withdrawn from the banking sector; (3) output falls; (4) a real depreciation occurs. The (non-financial) private sector is subject to the following budget constraint:

$$(1) \quad C_t = Y_t + q_t [B_t - (1+r_B)B_{t-1} + P_t - (1+r)P_{t-1} + Z_t],$$

where C_t is domestic consumption, Y_t is domestic output, q_t is the real exchange rate, B_t is the dollar short-term lending by banks to the private sector, P_t is the short-term external debt of the private sector, and Z_t is a transfer from the government. The interest rates r_B and r are constant. Consumers do not default on short-term external debt, so r is a risk free interest rate. Banks are subject to the following budget constraint:

$$(2) \quad B_t - (1+r_B)B_{t-1} + RB_t - (1+r)RB_{t-1} = D_t - (1+r_D)D_{t-1},$$

where RB_t is the amount of dollar deposits that banks invest in risk free short-term foreign assets (in dollars) at an interest rate of r , and D_t represent dollar deposits for which banks pay an interest rate of r_D . RB_t is assumed to be a constant fraction of short-term foreign currency deposits: $RB_t = \alpha D_t$, $0 < \alpha < 1$.¹ Furthermore, for simplicity, $r_D = r$ (introducing a premium in domestic foreign currency deposits would not fundamentally alter our results).

As in JR, the government issues a long-term security that is sold by the price P (assumed constant), and yields one unit of good every period until the sudden stop occurs, after which it stops yielding any income. Therefore, the price of this security before the sudden stop occurs is given by the present discounted value of its expected future returns,

$$P = \frac{1}{1+r+\delta} [1 + (1-\pi)P],$$

where π is the probability that a sudden stop occurs, r is the interest rate on short-term external debt, and δ is the term premium. Solving the expression above for P yields

$$(3) \quad P = \frac{1}{r + \delta + \pi}.$$

The long-term security is issued to finance a stock R_t of official reserves, implying that

$$(4) \quad R_t = PN_t,$$

¹ The model abstracts from moral hazard issues related to the fact that reserve accumulation by the central bank may cause banks to decide to hold less foreign currency assets. Levy-Yeyati (2006) focuses on this issue and obtains an optimal composition of reserves between the banking sector and the central bank.

where N_t is the number of long-term securities issued by the government in period t .

The government may also issue short-term foreign debt in non-sudden-stop periods. Therefore, before the sudden stop, government's budget constraint is given by:

$$(5) \quad P(N_t - N_{t-1}) - N_{t-1} + G_t - (1+r)G_{t-1} = Z_t + R_t - (1+r)R_{t-1},$$

where G_t is the short-term foreign debt of the government (the government does not default on its short-term external debt, implying that the interest rate on this debt is the risk free interest rate, r).

The subscripts b and d denote the periods before and during a sudden stop. Equations (4) and (5) can be used to substitute out P , N_t and N_{t-1} from government's budget constraint, yielding the expression for the government transfer to the private sector before the sudden stop,

$$(6) \quad Z_t^b = G_t - (1+r)G_{t-1} - (\delta + \pi)R_{t-1}.$$

The second term in equation (6) corresponds to the cost of carrying reserves, which is proportional to the term premium plus a default risk premium, captured by the sudden stop probability. To pay for this cost, the government taxes the consumer, reducing the government transfer. When a sudden stop occurs, private and public short-term external debt can no longer be issued. In order to smooth the effects on consumption of the sudden stop of external credit, the government transfers its official reserves to consumers, except for the amount $(\delta + \pi)R_{t-1}$, which it has to pay on its long-run security for the last time. Therefore, transfers during a sudden stop are given by

$$(7) \quad Z_t^d = -(1+r)G_{t-1} + (1 - \delta - \pi)R_{t-1}.$$

Assuming that $\delta + \pi < 1$, the term $(1 - \delta - \pi)R_{t-1}$ will be positive. In the long run output grows at a rate g . When the balance of payments crisis unfolds, a fraction of output γ is lost, and a fraction of dollar deposits ϕ is withdrawn from banks. Furthermore, the real exchange rate is constant and normalized to 1 before the crisis, and depreciates by Δq during the crisis. With these assumptions and the equations for the transfer in (6) and (7), the expressions for domestic consumption before and during the crisis are, respectively,

$$(8) \quad C_t^b = Y_t^b + (1 - \alpha)D_t^b + P_t^b + G_t^b - (1+r)\left[(1 - \alpha)D_{t-1}^b + P_{t-1}^b + G_{t-1}^b\right] - (\delta + \pi)R_{t-1};$$

$$(9) \quad C_t^d = (1 - \gamma)Y_t^b + (1 + \Delta q)\left\{(1 - \phi)D_{t-1}^b - (1+r)\left[(1 - \alpha)D_{t-1}^b + P_{t-1}^b + G_{t-1}^b\right] + (1 - \delta - \pi)R_{t-1}\right\}.$$

The government chooses the amount of reserves to maximize the expected welfare of consumers,

$$(10) \quad E(U_t) = E \left[\sum_{s=0}^{\infty} (1+r)^s u(C_{t+s}) \right], \text{ where } u(C) = \frac{C^{1-\sigma} - 1}{1-\sigma}.$$

The first order condition to this problem is

$$(11) \quad \pi \cdot (1 - \delta - \pi) \cdot (1 + \Delta q) \cdot u'(C_{t+1}^d) = (1 - \pi) \cdot (\delta + \pi) \cdot u'(C_{t+1}^b).$$

From equation (11), it can be shown that the optimal level of reserves before the sudden stop is a constant fraction of output,

$$(12) \quad R_t = \rho Y_{t+1}^b,$$

where the optimal ratio of reserves to output ρ is given by equation (1) in the text.

Appendix 2. Level Reserves Required to Cover a 2002-like Crisis

The total drop in short-term foreign currency deposits is the sum of the drop in nonresidents' deposits (ΔNR) and residents' deposits (ΔR) and can be written as follows:

$$\Delta D = \Delta NR + \Delta R = \frac{NR}{NR + R} \frac{\Delta NR}{NR} + \frac{R}{NR + R} \frac{\Delta R}{R}$$

The drop in NR and R is calibrated based on 2002 crisis, whereas the composition of deposits in terms of NR and R is obtained from actual data in each year. In other words, the drop in deposits in a particular year y is given by:

$$(13) \quad \Delta D_y = \left(\frac{NR}{NR + R} \right)_y \left(\frac{\Delta NR}{NR} \right)_{2002} + \left(\frac{R}{NR + R} \right)_y \left(\frac{\Delta R}{R} \right)_{2002}.$$

Similarly, the drop in short-term foreign currency debt (ΔL) can be written as $\Delta L = L(\Delta L / L)$ and the size of the drop is calibrated based on the 2002 crisis:

$$(14) \quad \Delta L_y = L_y (\Delta L / L)_{2002}.$$

The implied level of reserves is simply the level that would result if reserves were used to cover the fall in deposits and debt implied by equations (13) and (14). As a share of GDP, this would be

$$(15) \quad \rho_y = \frac{(\Delta D_y + \Delta L_y)}{GDP_y}.$$

VI. HAS THE FINANCIAL SYSTEM BECOME MORE RESILIENT TO SHOCKS? AN ANALYSIS ADAPTING THE MERTON FRAMEWORK TO A COUNTRY WITHOUT EQUITY MARKET DATA

By Marcos Rietti Souto

A. Introduction

1. ***Following substantial restructuring and enhanced supervision in the aftermath of the 2002 crisis, financial sector soundness indicators have strengthened considerably.*** The banking system is now profitable and has become better capitalized. It is also highly liquid, though this partly reflects a sharp reduction in lending. Nonperforming loans have fallen to 2 percent of total loans (excluding the housing bank) and non resident deposits, which proved volatile in the face of negative external developments, are well below pre-crisis levels. In addition, the regulation and supervision of the financial system has improved significantly. However, despite low short-term risks, important medium term vulnerabilities remain, particularly stemming from high dollarization (see also FSAP 2006).
2. ***This paper assesses the extent of remaining vulnerabilities of the banking sector using a variant of the Merton framework (1973, 1974).*** To this end, the study constructs a set of credit risk indicators, which are then used to compare banks' risk profile at the time of the 2002 banking crisis with today's conditions, and examines the impact of potential shocks on the various risk indicators. In contrast to the Merton framework, which uses market data to capture the collective views and expectations of market participants, this paper uses book value data from balance sheets due to the absence of market data in Uruguay. The approach still incorporates volatility into the estimations, a key feature of the Merton framework for capturing non-linearities in the credit risk indicators, especially during periods of distress.
3. ***Despite the simplifying assumptions, the methodology captures well several stylized facts of the 2002 banking crisis and suggests that the system has become more resilient.*** In particular, it identifies, as early as the first quarter of 2002, a deterioration in the credit risk indicators of the banking sector and, when applied to the corporate sector, a significant distress event toward the last quarter of 2002. The methodology also points to a substantial improvement in credit risk indicators since the 2002 crisis, in line with the restructuring process pursued over the last years. Consistent with the conclusions of the stress tests of the 2006 FSAP and the 2007 update prepared by the authorities, it shows that, notwithstanding important remaining vulnerabilities, banks have become more resilient to shocks. Thus, the methodology used in this paper appears to have the potential of being a useful toolkit to many economies that lack (or have shallow) equity markets.

B. The Merton Framework

4. ***The Merton framework offers clear advantages over traditional vulnerability analyses, including by incorporating volatility explicitly into the estimations.***¹ The approach

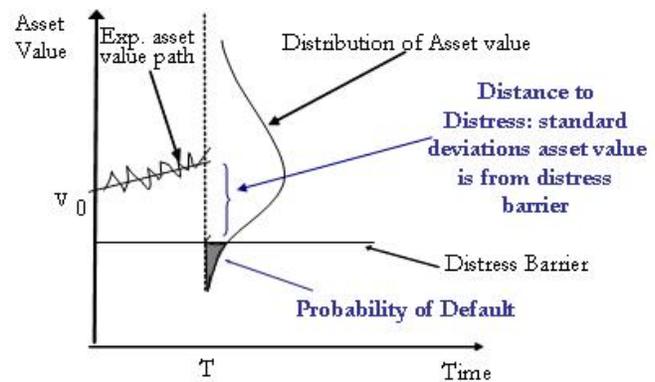
¹ See Gapen et al. (2004, 2005) and Dale and Jones (2006) for examples of application of the Merton framework to government, banking, and corporate sectors' balance sheets.

relies on observable market information on the value and volatility of liabilities (and equity) to derive the value of non-observable quantities, such as the asset value and asset volatility. This information is then combined to estimate risk indicators, such as the distance-to-distress (a measure of how far a firm is from defaulting), default probability, credit spread, and expected losses given a default. In contrast with more traditional vulnerability analyses, this framework incorporates market volatility when estimating credit risk. Volatility is crucial in capturing nonlinear changes in risk, especially during times of stress when small shocks can gain momentum and trigger systemic repercussions.

5. ***The basic idea is to model a firm's equity as a (junior) contingent claim on the residual value of its assets.***

In the event of default, all the firm's assets are used to pay the senior stake holders (e.g., debt holders); otherwise equity holders receive the difference between the value of assets and debt. Thus, the equity of the firm can be seen as a call option on the residual value of the firm's assets. This framework enables a rich characterization of a firm's (or sovereign's) balance sheet and the derivation of several credit risk indicators (e.g., distance to distress, default probability, and credit spreads) (Figure 1).

Figure 1. The Merton Framework



6. ***With information on the market value and volatility of equity and the value of debt, it is possible to estimate the implied value for assets and volatility through the Black and Scholes option formula.*** Firms are assumed to default whenever the value of assets fall below a given “distress” barrier. It is then possible to estimate a set of credit risk indicators, including distance-to-distress, default probability, credit spread, and expected losses in the event of default.²

7. ***Given the lack of an equity market in Uruguay, this study incorporates volatility into the estimation of credit risk indicators by using book value data.*** While this reduces to some extent its forward-looking nature, the approach still retains key characteristics, such as proper analysis of asset volatility. Moreover, balance sheet data appears to capture well changes in the financial health of Uruguayan banks during the sample period, without particularly long lags.

² Technical details are provided in Gapen et al. (2004, 2005).

C. The Stress Tests

8. *This section summarizes the main results of stress tests conducted by the 2006 FSAP and updated by the authorities in 2007.* It then assesses whether the banking system has become more resilient since the 2006 FSAP.

The 2006 FSAP stress tests

9. *The 2006 FSAP stress tests focused on the impact of shocks on banks' capital adequacy (CAR) and liquidity ratios.*³ The institutions included all private banks, cooperatives, finance companies, offshore banks, and the state owned Banco de la República Oriental del Uruguay (BROU); these institutions represented 80 percent of the

financial system assets. The stress tests were performed on exposures, on a bank-by-bank basis, as of June 2005. They included sensitivity analysis with respect to the interest rate, exchange rate, and credit risk, as well as macroeconomic scenarios involving a domestic supply shock (severe weather conditions), a current account shock (corresponding to a drop in Argentine GDP of 10 percent), and a capital account shock (corresponding to a rise in the three-month Libor to seven percent per year) (Table 1).

10. *The 2006 results indicated that banks have improved considerably, but remained vulnerable to severe shocks.* Following these large shocks, several institutions would be undercapitalized or with their CAR falling below the minimum required capital ratio, particularly under the capital account shock scenario. However, banks appeared to be resilient to moderate fluctuations in the exchange rate, interest rate, liquidity, and credit reclassification, with only few institutions having their CAR falling below the minimum required capital ratio.

Table 1. 2006 FSAP: Stress Tests Assumption

Risk factor	Current Account	Capital Account
	Shock	Shock
Δ Real exchange rate	5%	12%
Δ Argentina private consumption	-10%	-10%
Δ Argentina nominal exchange rate	45%	45%
Δ Argentina real exchange rate	30%	30%
Δ Foreign prices	-5%	-13%
Δ Domestic prices	7%	15%
Δ Nominal exchange rate	17%	48%
Δ GDP 1/	-4%	-8%
Country risk 2/	500 to 550 b.p.s.	> 600 b.p.s.

Source: BCU staff calculations.

1/ GDP gap where long-term GDP growth is equal to 3 percent.

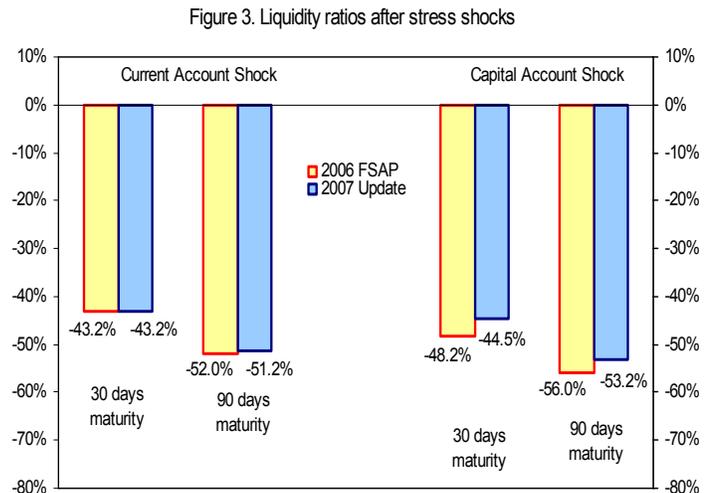
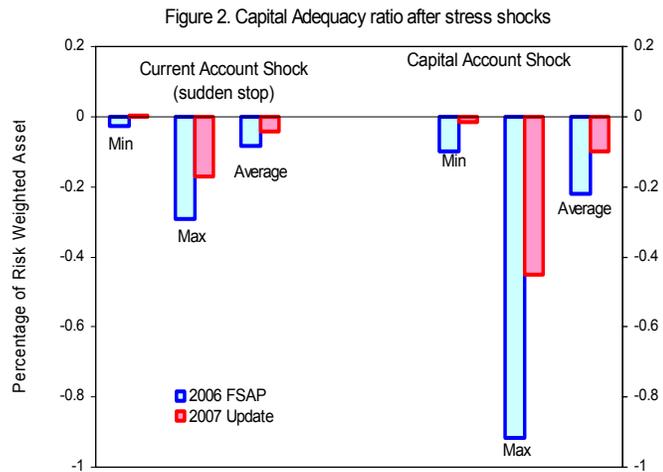
2/ The country risk was calibrated according to similar historical episodes.

³ For more details on the stress tests' assumptions, see Appendix 2 of the Uruguay FSSA, February 2006.

The stress test update

11. *The 2007 update of the stress tests indicate that banks are more resilient to economic shocks.* The exercise was updated using December 2006 data for shocks that yielded the worst results in the 2006 FSAP. The current account shock results in a drop of the average CAR of 4 percent now, against 8 percent in the 2006 FSAP; the capital account shock yields a drop of 10 percent, against 22 percent in the 2006 FSAP (Figure 2).

Liquidity ratios dropped modestly in the 2007 update, compared to the 2006 FSAP exercise. Under the current account shock scenario, liquidity ratios for assets and liabilities maturing in 30 days or less fell, on average, 43 percent in both 2006 FSAP and 2007 update; under the capital account shock scenario, these ratios fell, on average, 48 percent in the 2006 FSAP and 45 percent in the 2007 update. Similar drops in liquidity ratios are observed for assets and liabilities maturing in 90 days or less (Figure 3).



D. The Modified Merton Framework

12. *This section uses the modified Merton framework to assess whether credit risk indicators capture well the main stylized facts of the 2002 banking crisis and the ensuing recovery.* Also, the framework is used to estimate the impact of current and capital account shocks, replicating those defined in the stress tests, in an effort to incorporate volatility as an additional dimension to these tests, which rely only on assets and liabilities levels.

Estimating risk indicators

13. *To estimate credit risk indicators, it is key to adjust balance sheet data to better reflect underlying values and volatilities.*⁴ First, beyond the deterioration in assets reflected through provisions, the data was adjusted by the expected losses arising from companies facing the same shocks. Second, the data was adjusted to take into account the liquidity/capital support provided during the 2002 crisis (US\$2.4 billion), which was masking the decrease in total assets value and volatility in the published financial statements (Table 2).

14. *The expected losses from the corporate sector were estimated using the modified Merton framework.* Despite the limitations of the methodology (see appendix for the technical details), the results appear to be in line with the stylized facts: in 2002, there was an increase in expected losses from companies that defaulted, owing partially to a higher volatility of total assets; in subsequent years, once the volatility of assets declined and the balance sheet accounts improved, expected losses returned to the pre-crisis levels (Figure 4).⁵

15. *The adjusted book value data for 12 banks were used to estimate time series for credit risk indicators for the banking sector.*⁶ With the adjusted set of assets and assets' volatilities, a time series of default probabilities for each individual bank was estimated—with the default

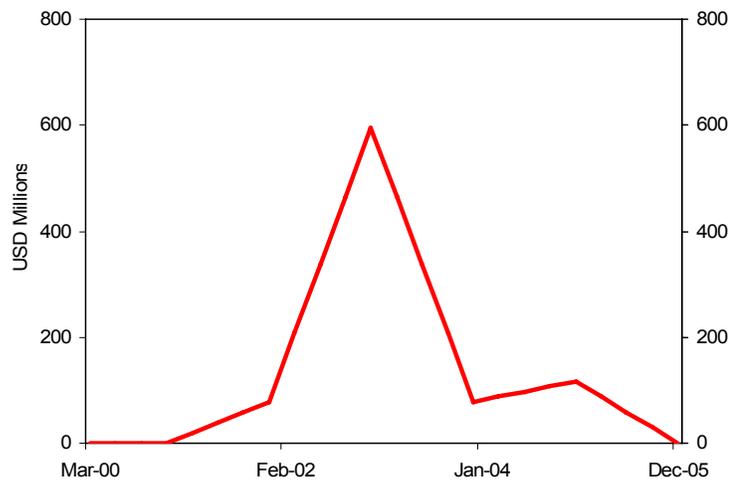
Table 2. Total Government Assistance to Banks 1/
(In millions of U.S. dollars, as of August 2002)

	Total	Public Banks	Private Banks
Total assistance	2,417	1,228	1,189
Of which: in pesos	33	10	23
Capitalization	33	0	33
Central bank	563	258	305
Article 36/37	391	258	133
Overdraft	173	0	173
FFSB (Jun. 2002)	449	0	449
FSBS (Aug. 2002)	1,373	970	403

Source: Seelig (2006).

1/ Includes assistance in pesos, evaluated at Ur\$28.8/US\$.

Figure 4. Expected losses given default in the corporate sector.



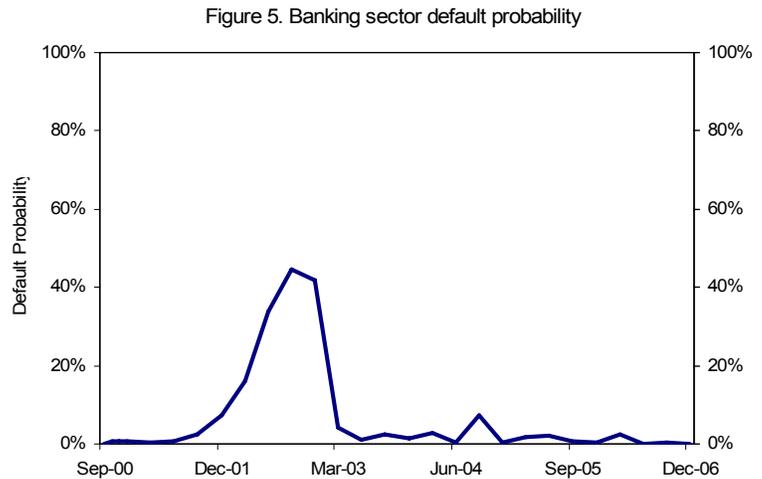
⁴ A capital injection to the banking system, for example, would mask the real volatility in the assets being depleted to meet the deposit withdrawals from a deposit run.

⁵ The sample of firms used to construct a time series on total assets and estimate their volatility is taken from De Brun et al (2006) and covers the period 1995–2005.

⁶ The twelve banks covering 70 percent of the system are BROU, Banco A.C.A.C., Discount Bank, Santander, Frances Bank, HSBC, Surinvest, Citibank, ABN Amro Bank, BankBoston, Lloyds Bank, and Banco de La Nacion Argentina. Quarterly balance sheet data is available for 2000–2001 and monthly data for 2002M1 to 2006M12.

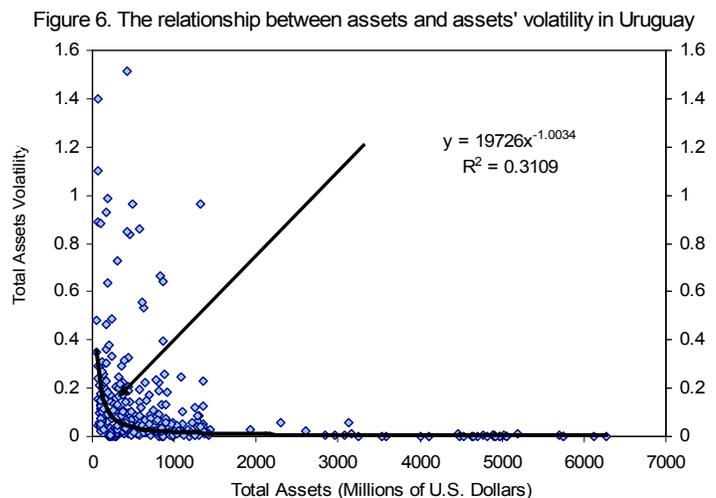
probability of the banking sector estimated by applying, to the individual default probabilities, a weighted average (based on each banks' proportion of total assets).

16. *The estimated default probability (EDF) of the banking system using the modified Merton framework appears to be sensible.* The framework predicts a near-zero 1-year default probability (with volatility measured over total assets) prior to the 2002 crisis; this suggests that the 2002 shock was largely unanticipated (in line with the results found in Chapters II and III). However, beginning in March 2002, the estimated default probability starts to increase, reaching 45 percent in September 2002. Since then, the default probability has declined substantially, to near zero by end-2006 (Figure 5). This is consistent with a reduction in assets volatility and the substantial "clean-up" in banks portfolios associated with the restructuring process.

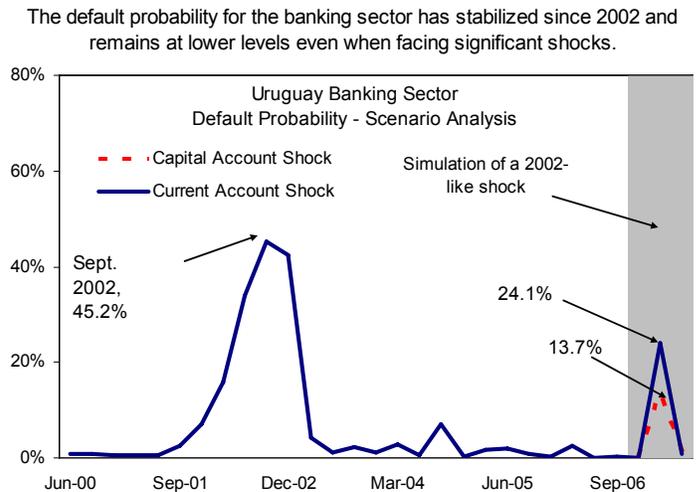


Using the modified Merton framework

17. *The modified Merton framework can be used to simulate the impact of potential shocks on the EDF.* This simulation provides a basis to assess the strength of the improved risk indicators beyond the traditional stress tests. In particular, given that volatility is a key parameter of the EDF, the near zero probability of default is to a large extent the result of the currently low volatility environment. Since standard stress tests only provide information on banks' assets and liabilities levels following shocks, this paper simulates assets' volatilities consistent with the after-shock level of assets. For this purpose, a historical relationship between total assets and their volatility is constructed for all banks to estimate the after-shock assets' volatilities (Figure 6).



18. *A simulation of a 2002 crisis-like scenario shows that banks have become more resilient to shocks, further confirming the thrust of the FSAP's stress tests results.*⁷ Using the FSAP's severe capital and current account shocks, the default probabilities reach 24 percent and 14 percent respectively, far below the 45 percent default probability predicted by the model for the peak of the 2002 crisis. However, default probabilities under a 2002 crisis-like stress scenario remain significant, thus underscoring the need to further reduce vulnerabilities in the banking system (Figure 7).



E. Concluding Remarks

19. *The results of a modified Merton framework, applied to the case of the Uruguayan banking system, appear to be promising for countries without equity markets.* While the methodology is based on balance sheet information, and not on market valuations, the time series for the estimated asset volatilities and default probabilities seem quite sensible. Indeed, they track well the deterioration of the system during the 2002 crisis. The modified Merton framework also proves useful to simulate the effects on individual banks of possible changes in macroeconomic conditions—and, by incorporating volatility into the analysis, improves upon conventional stress tests that rely only on asset and liability levels.

20. *While still significant, the analysis suggests that vulnerabilities have continued to decline, further confirming the FSAP stress tests results.* The estimated default probability reaches only half the level measured at the peak of the 2002 crisis, even under a substantial shock to the capital account; and the impact of a shock to the current account is even smaller. The results also show, however, that important vulnerabilities remain. Thus, it will be essential to continue deepening financial sector reforms over the medium-term.

⁷ This is not surprising since the results from the stress tests are used to shock the modified Merton framework.

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Appendix—Estimating Risk Indicators for the Corporate and Banking Sectors

Estimating Corporate Sector Expected Losses

The main challenge consists in generating a consistent time series on total assets to estimate volatilities on total assets returns. This challenge arises because the sample size (number of firms) in the dataset changes over time. An estimate of total assets as the sum across all firms at each point time, may capture variations in total assets that are simply due to changes in the dataset sample. To control for this fact, Mitton (2006) suggests to estimate the following panel regression for the average firm within the firm:

$$(1) \quad \text{Total Assets}_{it} = \alpha + \text{Firm}_i + \beta \cdot \text{Year}_t + \varepsilon_{it},$$

where Firm_i represents firm-fixed effects and Year_t represents a full set of year-specific dummy variables. The time series on the total assets is then constructed as:¹

$$(2) \quad \text{Total Assets}_t = \hat{\alpha} + \hat{\beta}_t,$$

This estimate provides a complete time series for (annual) total assets covering the period of 1994-2006, which makes it possible to estimate returns as continuously compounded, that is $r_t = \ln(TA_t / TA_{t-1})$. To estimate volatilities, it is then possible to use an exponentially weighted moving average (EWMA):

$$(3) \quad \sigma_t^2 = r_t^2, \text{ for } t = 1994,$$

$$(4) \quad \sigma_t^2 = (1 - \lambda)r_t^2 + \lambda\sigma_{t-1}^2, \text{ for } t = 1995, 1996, \dots, 2006,$$

where r_t is the return on the total assets at time t , λ is the decay factor (we are using $\lambda = 0.95$, following common practice), and σ_t^2 is the volatility at time t .

It is instructive to express the distance-to-distress in another (approximated) way:

$$(5) \quad D2D = \frac{TA - DB}{TA \cdot \sigma_{TA}} = \frac{TA - DB}{\sigma_{TA}},$$

where TA is the total assets, DB is the distress barrier, and σ_{TA} is the volatility of total assets. The numerator of expression (5) is component 1, which represents the distance of total assets to the distress barrier, as a fraction of total assets (how far from distress). The

¹ There are also missing observations for 2002 and 2006. To obtain the value for 2002, the average values for total assets for 2000, 2001, 2003, and 2004 are used. To obtain the value for 2006, the average growth on total assets from 2003 to 2005 is used.

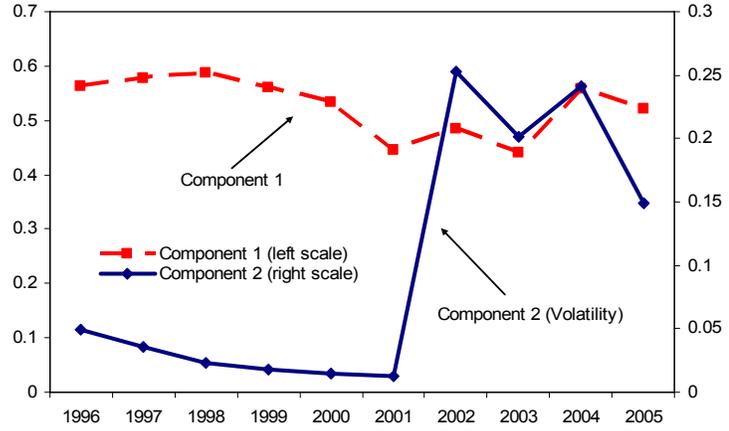
denominator, σ_{TA} , is component 2. Figure A1 depicts the evolution of the components of distance to distress for the corporate sector.

It is clear that: (i) volatility increased substantially in 2002, consistent with the banking crisis that led to a depreciation of the peso, and adversely affecting companies with a substantial exposure to FX rate risk; (ii) after 2002, volatility declines, but still remains above pre-crisis levels; and (iii) component 1,

$\left(\frac{TA - DB}{TA}\right)$, started to decline in

1999, reaching its lowest levels in 2001–03 and showing rising balance sheet mismatches in the corporate sector. Component 1 improves slightly in 2004, but still remains below pre-crisis levels.

Figure A1. Uruguay's corporate sector: components of distance to distress



With information on assets, assets volatility, interest rate, and liabilities, it is possible to obtain the expected losses, given default (Merton, 1977):

$$(6) \quad P = Be^{-rt}N(-d_2) - AN(-d_1),$$

where P represents the expected losses, B represents the distress barrier, r is the risk-free interest rate, t is the maturity (for the sake of simplicity, we are looking into 1-year ahead measures), A is the total asset, and d_1 and d_2 are known parameters in the Black and Scholes formula.²

Estimating Banking Sector Default Probability

To estimate volatility for banks' total assets, it is first necessary to construct a time series of return on assets as $r_t = \ln(TA_t / TA_{t-1})$. Then, like for the corporate sector, volatilities are estimated using the EWMA updating expressions:³

$$(7) \quad \sigma_t^2 = r_t^2, \text{ for } t = 2000Q1 \text{ or } 2002M1,$$

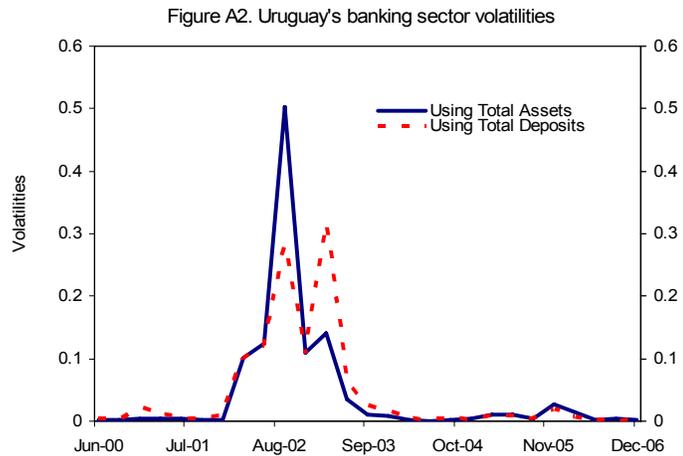
$$(8) \quad \sigma_t^2 = (1 - \lambda)r_t^2 + \lambda\sigma_{t-1}^2, \text{ for } t = 2000Q2, \dots, 2001Q4 \text{ or } 2002M2, \dots, 2006M12.$$

² See Hull (2000) for the precise formulae and definition.

³ For banks we also use $\lambda = 0.95$.

It is also possible to estimate volatilities using time series on return on deposits. Since changes in deposits may be viewed as a measure of customer's confidence in the bank, it may be a better proxy for 'market-related' volatility. We use both sets of volatility to estimate risk indicators. Both approaches yielded similar results.

The liquidity shock hitting the banking sector in 2002 is captured. Liquid assets were drained at a fast pace in an effort to meet the increasing deposit withdrawals that followed the Argentinean crisis. Following this event, volatilities remained at low levels, reflecting the restructuring of the banking sector. The second hump in deposits volatilities reveal a second run of depositors that took place early in 2003 (Figure 12A2).



Once asset volatility has been estimated, it is then possible to estimate distance-to-distress and default probability for each bank individually.⁴ Risk indicators for the banking sector can be obtained as weighted averages of individual banks, weighted by banks total assets.

⁴ See Gapen et al (2004, 2005) for details on the formulas.