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Depositor Behavior under Macroeconomic Risk: Evidence from Bank Runs in Emerging Economies

Depositor behavior has been associated with bank-specific characteristics, random runs, or contagion episodes. Using evidence on the 2000–02 bank runs in Argentina and Uruguay, this paper shows that macroeconomic risk is also important. Few macroeconomic shocks can quickly cause large runs. Macroeconomic risk affects deposits regardless of traditional bank-specific characteristics. Furthermore, bank exposure to macroeconomic factors can explain differences in deposit withdrawals. During crises, the evolution of bank-specific characteristics is mainly driven by macroeconomic factors, while the informational content of bank-specific variables declines. Overall, depositors seem responsive to risk in a broader sense than that often considered by the literature.

JEL codes: F30, F41, G14, G21, G28
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RECENT EPISODES OF bank runs, including those during the 2007–08 financial crisis, together with policy initiatives to foster banking sector soundness, such as Basel II, have reignited the interest in understanding what drives the behavior of depositors.[1] Current thinking and research on how depositors behave primarily emphasize their response to bank-specific characteristics, what is known in banking as market discipline. Others discuss the possibility that generalized deposit runs can be random events or be triggered by contagion from weak banks. This paper shows that macroeconomic risk can also exert a significant—and, in many cases, decisive—influence on the evolution of bank deposits.

Market discipline in banking is often described as a situation where depositors face costs that are positively related to bank risk and react on the basis of these costs (Berger 1991). For example, depositors respond to increases in bank risk—reflected in bank-specific characteristics—by demanding higher interest rates on their deposits or by withdrawing their funds, penalizing managers for excessive risk taking. If present, market discipline will tend to lower the probability of individual bank failures and the incidence of banking crises, and lead to a healthier banking sector as a whole. There is a vast academic literature on the subject.[2] Studies such as Flannery (1998) and Sironi (2003) offer evidence of market discipline in banking for the United States and Europe, respectively. D'Amato, Grubisic, and Powell (1997), Gonzalez-Hermosillo (1999), Barajas and Steiner (2000), Schumacher (2000), Calomiris and Powell (2001), Budnevich and Franken (2003), Ghosh and Das (2003), McCandless, Gabrielli, and Rouillet (2003), and Opiela (2006) find support for the existence of market discipline in developing countries. However, a number of papers find that in developing economies traditional indicators of bank health tend to become less significant and explain a smaller fraction of the total variance of deposits and interest rates during crisis episodes than during tranquil times. As a result, the typical test of market discipline might fail at times, despite the fact that market discipline seems to be present in noncrisis periods (Martínez Pería and Schmukler 2001, Arena 2003, de la Torre, Levy-Yeyati, and Schmukler 2003).

Parallel to the discussion on market discipline, there is an important literature on bank runs within countries. Part of the literature has associated these events with panics unrelated to bank-specific characteristics or with runs on weak banks that eventually trigger deposit withdrawals from the entire banking sector. For example, Calomiris and Gorton (1991), Calomiris and Schweikart (1991), Kaufman (1994), Saunders and Wilson (1996), Calomiris and Mason (1997), Kelly and O Grada (2000), and O Grada and White (2002) provide several historical examples of both panics that resulted in generalized banking crises and large spillovers that generated from small

1. Basel II's pillar 3 lays out a number of disclosure requirements that banks are recommended to comply with to enhance market discipline. As stated by the Bank for International Settlements (2001), "market discipline has the potential to reinforce minimum capital standards (pillar 1) and the supervisory review process (pillar 2), and so promote safety and soundness in banks and financial systems."

2. A related literature examines whether market information (such as bond and equity market indicators) helps to predict bank fragility (Krainer and Lopez 2004, Gropp, Vesala, and Vulpes 2006).

disturbances in a narrow subset of banks.[3] However, Calomiris and Gorton (1991) show that U.S. banking panics prior to World War I are explained by high-frequency macroeconomic events. Furthermore, Calomiris and Mason (2003) show that both low-frequency bank data and high-frequency local and national level macroeconomic environment indicators contributed to the U.S. bank distress of the 1930s.

This paper studies in detail how macroeconomic risk can affect the behavior of bank depositors and the banking sector in general, ultimately having an impact on the extent of and the way in which bank runs occur. These macroeconomic factors are initially exogenous to the banking system, hit all banks simultaneously (though not necessarily symmetrically), and tend to become particularly important during crisis times.

Macroeconomic risk can influence depositor actions both regardless of and through bank-specific characteristics. The effects of macroeconomic factors beyond bank-specific characteristics can take place when worsening macroeconomic conditions directly threaten the value of market participants' assets (such as bank deposits). Classic examples of direct macroeconomic effects are currency and sovereign risks. In the first case, depositors might flee from domestic banks, irrespective of individual bank fundamentals, if convertibility to a foreign currency is not an option. In the second case, sovereign risk may affect market reaction as it reduces the government's capacity to insure deposits or the central bank's ability to provide liquidity assistance to banks facing deposit withdrawals, increasing the level of bank risk as perceived by depositors. The effects of macroeconomic risk on depositor behavior through bank-specific characteristics can take place either via exposure to macroeconomic risk (not typically captured by the most frequently used indicators) or via a gradual deterioration of traditional bank-specific characteristics. An example of exposure to macroeconomic risk not captured by typical bank-specific measures of fundamentals is foreign currency lending. In financially dollarized economies, where banks match their foreign currency funding with foreign currency lending, exchange rate devaluations may significantly increase credit risk as they impinge on the repayment capacity of unhedged foreign currency borrowers (e.g., those in the nontradable sector). A gradual deterioration in traditional bank-specific indicators due to macroeconomic risk might occur, for example, as a result of an increase in sovereign risk, which will negatively impact the return on assets of those banks holding government paper.

To document the importance of macroeconomic risk on the behavior of depositors, we focus on the bank run episodes in two emerging economies, Argentina and Uruguay, during 2000–02.[4] Though surely not the only cases in which macroeconomic risk might have played an important role, the difficulty in gathering detailed

3. A separate literature analyzes banking crises across countries. See, for example, Caprio and Klingebiel (1997), Kaminsky and Reinhart (1999), and Bordo et al. (2001).

4. A brief summary of the events surrounding the two crises can be found in the working paper version of this paper (Levy-Yeyati, Martínez Pería, and Schmukler 2004a). For a detailed account of the crisis in Argentina, also see de la Torre, Levy-Yeyati, and Schmukler (2003) and Perry and Servén (2004). For more information on the Uruguayan crisis, see Porto (2002), Fernández, Garda, and Perelmuter (2003), and Vallcorba (2003).

data forces us to restrict the analysis to just a couple of countries. With the collaboration of the respective central banks, we were able to obtain rich data sets that are not publicly available and that allow us to test different hypotheses regarding depositor behavior during crises. Moreover, the fast and widespread collapses of these countries' banking systems, illustrated in Figure 1, surprised many analysts, particularly given the *ex ante* relatively good health of their bank indicators.[5] In both cases, we track a set of significant macroeconomic factors (including news events) and investigate how they affected bank deposits.

The analysis of these two crises leads to the following results. First, using both monthly and daily data, we show that macroeconomic shocks can quickly cause banking system collapses, while low-frequency bank-specific factors do not explain these events. These episodes are not random or driven by contagion across banks. Macroeconomic factors that are largely irrelevant to explain depositor behavior during tranquil times become the main driver of market response during crisis episodes, even after controlling for standard bank-specific traits. Indeed, we show that relatively few macroeconomic shocks can easily destabilize an entire banking system and explain the generalized withdrawals experienced during the crises under study. Second, we show that, despite the fact that bank-specific exposure to macroeconomic factors is not factored in banks' funding costs in the precrisis period, deposit withdrawals during the crises are positively associated with banks' exposure to exchange rate risk. Finally, we illustrate how the informational content of bank-specific characteristics deteriorates relative to macroeconomic factors as aggregate risk mounts, which explains why risk-aware depositors may increase their response to macroeconomic indicators at the expense of bank-specific characteristics. In particular, we show that, when trying to explain bank-specific characteristics further into the future, the explanatory power of past bank-specific variables declines relative to that of macroeconomic factors. This effect is not entirely driven by bank information being known with a lag.

The rest of the paper is organized as follows. Section 1 describes the data. Section 2 evaluates the effect of macroeconomic factors on depositor behavior. Section 3 examines the informational content of past bank-specific characteristics vis-à-vis macroeconomic risk factors. Section 4 discusses policy implications and concludes.

1. DATA

To examine the impact of macroeconomic risk on depositor behavior, we use both macro-/country-level and bank-level data sets. As part of the measures of

5. For example, in both Argentina and Uruguay bank capital exceeded that observed in other countries in the region. The average capital-to-asset ratio was approximately 20% for banks in Argentina and 14% for banks in Uruguay, while it hovered around 13% in Chile, Peru, and Mexico, and 11% in Colombia. In Argentina, the regulatory reform initiated after the 1995 crisis led to well-capitalized, highly liquid, strongly provisioned banks that prompted the World Bank to place Argentina second among 12 emerging economies (World Bank 1998).

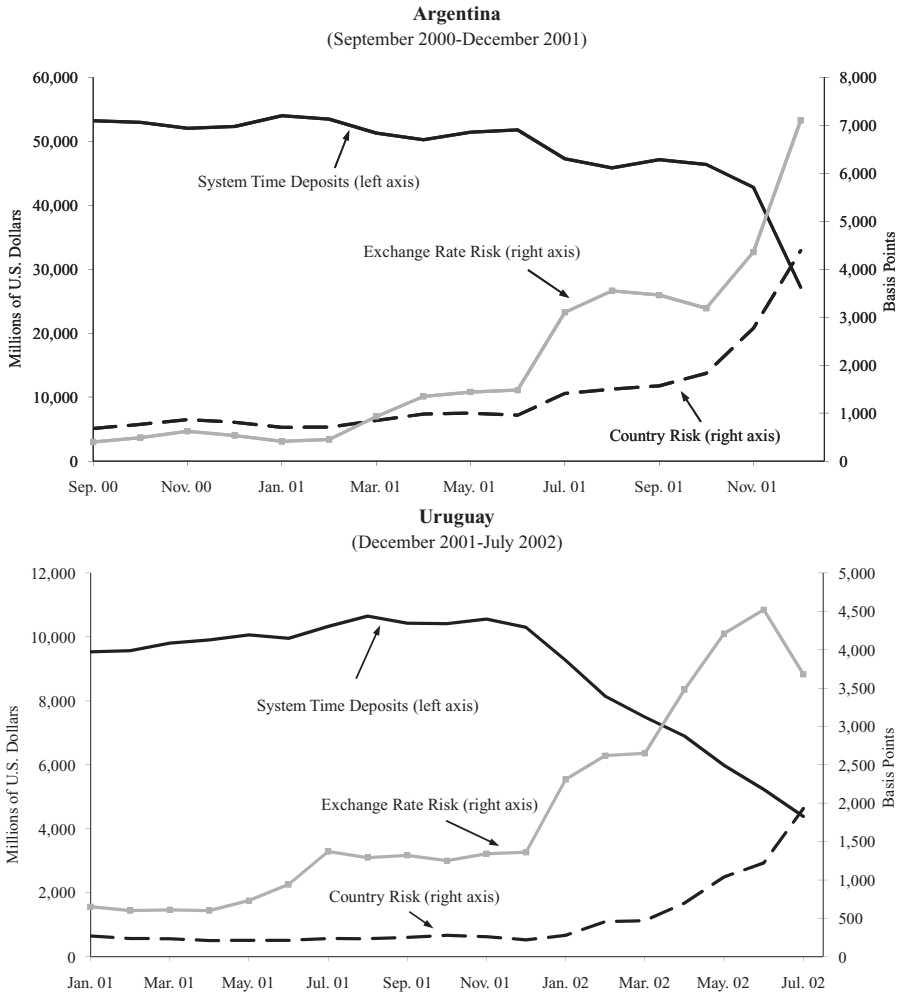

FIG. 1. Evolution of Time Deposits and Macroeconomic Factors.

NOTE: This figure shows the evolution of monthly system time deposits, country risk, and exchange rate risk for Argentina and Uruguay. Data on deposits are end-of-the-month values. Data on exchange rate and country risk are monthly averages.

macroeconomic risk, we use monthly and daily country-level information on country and exchange rate risk. We measure country risk for each country by the spread on Argentine and Uruguayan sovereign bonds over comparable U.S. bonds, as expressed in Argentina's Emerging Market Bond Index Plus or EMBI+ (provided by J.P. Morgan) and the Uruguay Bond Index or UBI (from República AFAP, an Uruguayan state-owned pension fund), respectively. Exchange rate risk (or, more precisely, the

currency premium) is measured by the 12-month nondeliverable forward exchange rate relative to the spot exchange rate for Argentina. These data come from Bloomberg. In the case of Uruguay, we use the spread of the average interest rate on peso time deposits (in the top private banks with maturity of more than 1 month and less than 6 months) relative to the rate on similar dollar deposits. This information comes from the Central Bank of Uruguay. Figure 1 shows the evolution of these macroeconomic variables for both Argentina and Uruguay.

Bank-level data come from the central banks. For Argentina, our sample includes 50 banks, accounting for 85% of total bank assets at the beginning of the crisis. For Uruguay, we work with data on 26 banks, accounting for 97% of total bank assets at the beginning of the crisis. Our main bank-level variable of interest is deposits. For each bank, we examine both daily and monthly data on bank deposits. In the case of Argentina, we use data on local and foreign currency deposits, since both are equally important. In the case of Uruguay, we focus only on foreign currency deposits, since they account for over 80% of bank deposits during the sample. To complement the analysis, we also use deposit interest rates across banks. Table 1 shows descriptive statistics for the percentage change in deposits from start to end of the crises.

In addition to deposits and interest rates, our study includes a number of variables and financial ratios derived from monthly bank balance sheets and income statements. In particular, we use data on total assets, nonperforming loans to total loans, capital to assets, and return over assets. Furthermore, to quantify banks' exposure to macroeconomic risk, we compute bank-level ratios on exposure to country and exchange rate risks. Exposure to country (sovereign default) risk is proxied by the share of government debt (bonds and loans) over total bank assets. We use three alternative measure of exposure to currency risk: the ratio of dollar loans over total bank assets, the ratio of dollar liabilities over total liabilities, and the ratio of dollar deposits to total liabilities. Table 1 reports averages across banks at the start of the crises for the main bank-level ratios used in the analysis.

2. DEPOSITOR BEHAVIOR AND MACROECONOMIC RISK

To evaluate the effect of macroeconomic risk on bank deposits, we follow three distinct approaches. First, we begin by running regressions similar to those in the traditional market discipline literature. For each country, we conduct panel regressions using monthly bank-level information on deposits and bank characteristics, and study the impact of macroeconomic factors by adding to such regressions standard measures of country and exchange rate risks.[6] To assess whether the explanatory power of macroeconomic factors becomes relatively more important in times

6. Similar exercises were conducted using interest rates instead of deposits. The results are in line with those reported below and were omitted in the interest of space and because estimations were only possible for a shorter period. These results can be consulted in the working paper version of this paper (Levy-Yeyati, Martínez Pería, and Schmukler 2004a).

TABLE 1

DESCRIPTIVE STATISTICS

	Argentina	Uruguay
Number of banks in the sample	50	26
Percentage of banking sector assets captured by banks in the sample at the start of the crisis	85	97
Average size of banks in the sample at the start of the crisis (millions of U.S. dollars)	2,932	806
Percentage change in dollar deposits from start to end of the crisis (average across banks)	−38%	−67%
Percentage change in dollar deposits from start to end of the crisis (median across banks)	−42%	−68%
Maximum percentage change in dollar deposits (across banks) from start to end of the crisis	−75%	−98%
Minimum percentage change in dollar deposits (across banks) from start to end of the crisis	10%	−26%
Percentage change in peso deposits from start to end of the crisis (average across banks)	−70%	n.a.
Percentage change in peso deposits from start to end of the crisis (median across banks)	−71%	n.a.
Maximum percentage change in peso deposits (across banks) from start to end of the crisis	−94%	n.a.
Minimum percentage change in peso deposits (across banks) from start to end of the crisis	−22%	n.a.
Average capital asset ratio across banks at the start of the crisis	0.20	0.08
Average nonperforming loan ratio across banks at the start of the crisis	0.20	0.05
Average monthly return on assets across banks at the start of the crisis	−0.01	−0.01
Average government debt/assets across banks at the start of the crisis	0.17	0.05
Average dollar loans to total loans across banks at the start of the crisis	0.24	0.74
Average dollar liabilities to total liabilities across banks at the start of the crisis	0.58	0.94
Average dollar deposits to total liabilities across banks at the start of the crisis	0.35	0.51

NOTE: This table describes the sample and some of the bank-level data used in the analysis of depositor behavior during the Argentine and Uruguayan crises. For Argentina, deposit changes are calculated between September 2000 and December 2001. For all other bank-level variables, averages across banks are reported at the start of the crisis (September 2000). In the case of Uruguay, deposit changes are computed between December 2001 and July 2002. For all other bank-level variables, averages across banks are reported at the start of the crisis (December 2001). In the case of Uruguay, the capital ratio is not the regulatory capital ratio but the ratio of equity to assets. n.a. means not available.

of macroeconomic distress, we run these tests both for the crisis and the precrisis periods.

During crisis periods, risks are likely to change daily and news events are expected to affect depositor behavior in ways not likely to be captured by the panel estimations. Thus, our second approach uses daily data to analyze depositor reactions to macroeconomic risk. In particular, we pursue an event study approach to examine the impact of news and, separately, we estimate vector autoregressive regressions (VARs) to account for the influence of daily changes in macroeconomic factors. In the daily VAR analysis, we include news as an additional macroeconomic factor.

Finally, we investigate whether deposit withdrawals were more severe among banks with larger exposures to macroeconomic factors and whether these exposures were priced by the market *ex ante*. We discuss each of these three approaches and present the corresponding empirical results below.

2.1 Traditional Panel Estimates Using Monthly Data

Our baseline panel specification is as follows,

$$D_{i,t} = \alpha_i + \beta' F_{i,t-4} + \lambda' S_t + \varphi A_{t-4} + \varepsilon_{i,t}, \quad (1)$$

where i is the bank and t is the period (month) identifier. D stands for the log of time deposits. F stands for bank-specific characteristics; it is a matrix of bank-level ratios that are intended to capture banks' asset quality, profitability, and capitalization levels. S, which stands for macroeconomic risk, is a matrix that includes measures of country and exchange rate risks as described in Section 2. All regressions also control for size (proxied by the log of total bank assets, A) and bank-specific effects, α_i.

There are three methodological issues related to the estimation of equation (1) worth mentioning. First, bank-specific variables are lagged. Since, in both countries, balance sheet data are released to the public by bank regulators with a delay of 3 to 4 months, we lag bank-specific characteristics to capture more precisely the information set available to depositors at each point in time. This lag structure also helps reduce potential endogeneity problems. Second, in this paper we focus on the log level of deposits, which tend to be less noisy than high-frequency changes of deposits.[7] Third, in analyzing how deposits respond to bank-specific characteristics and macroeconomic risk, we examine the joint significance of bank-specific attributes in the period before and during crises and we calculate and compare the variance explained by bank-specific and macroeconomic factors across periods. We think that these tests are more informative of the relative importance of bank-idiosyncratic and aggregate factors than tests performed on individual coefficients of bank-specific characteristics.[8] These tests are also more functional to the goal of this paper, which is not to argue that bank-specific attributes are not important but rather to show that macroeconomic factors are relevant as well.

Results for Argentina and Uruguay are shown in Tables 2 and 3, respectively. For each country, we report separate estimations for the precrisis and crisis periods. In the case of Uruguay, given its importance as a financial center for Argentine residents, we distinguish between two crisis subperiods: before and after the implementation of the "corralito" in Argentina—a measure taken by authorities at the end of 2001 to stop the run on deposits, which implied the imposition of limits on cash withdrawals from bank accounts. This measure reverted the flow of deposits from Argentine residents to Uruguay.[9]

Simple inspection of the tables reveals similar patterns for Argentina and Uruguay. In the precrisis period, bank-specific attributes are either significant and of the

7. The working paper version of this paper also shows results with deposit changes, which yield similar conclusions.

8. The latter are typically correlated with each other and their individual coefficients may vary considerably with the sample, hence our preference for joint tests.

9. The name "corralito" (little fence) was initially adopted because deposits could be used freely inside the financial system but could not leave the system. This measure should not be confused with the forcible reprogramming of time deposits that followed in January 2002, referred to as the "corralón" (large fence).

TABLE 2

MARKET REACTION TO BANK-SPECIFIC CHARACTERISTICS AND MACROECONOMIC RISK: DEPOSIT LEVEL—ARGENTINA

	Log of peso time deposits				Log of dollar time deposits			
	Precrisis period	Crisis period			Precrisis period	Crisis period		
	Oct. 98–Jul. 00	Sep. 00–Dec. 01			Oct. 98–Jul. 00	Sep. 00–Dec. 01		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 − nonperforming loans/total loans ($t-4$)	0.93	−0.01	0.05	−0.05	−0.12	0.29	0.24	0.25
	[1.68]	[0.04]	[0.17]	[0.19]	[0.35]	[1.68]	[1.39]	[1.27]
Capital/assets ($t-4$)	1.90	0.11	−0.05	0.49	0.32	0.45*	0.58**	0.73**
	[1.82]	[0.33]	[0.14]	[1.28]	[0.98]	[2.14]	[2.67]	[2.96]
Return on assets ($t-4$)	7.33**	4.00**	3.83**	4.19**	2.51*	0.28	0.42	0.42
	[2.88]	[4.79]	[4.44]	[4.60]	[2.33]	[0.52]	[0.75]	[0.65]
Log of assets ($t-4$)	0.50*	0.00	0.04	0.13	0.40**	−0.03	−0.06	0.06
	[2.37]	[0.02]	[0.26]	[0.91]	[4.35]	[0.39]	[0.72]	[0.68]
Country risk (t)	5.13	−3.10**	−4.17**		−0.75	−2.25**	−1.41**	
	[1.50]	[5.12]	[13.58]		[0.42]	[8.86]	[11.73]	
Exchange rate risk (t)	0.59	−0.56**		−1.92**	−0.14	0.44**		−0.54**
	[0.41]	[2.79]		[14.18]	[0.18]	[4.69]		[8.85]
Bank dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	369	537	537	537	363	539	539	539
Within R^2	0.30	0.73	0.72	0.68	0.13	0.55	0.52	0.38
F-test for bank-specific characteristics (p-value)	0.00	0.00	0.00	0.00	0.08	0.04	0.02	0.01

NOTE: This table reports fixed-effects regressions with robust standard errors of peso and dollar time deposits on bank-specific factors and macroeconomic risk indicators. The table is based on monthly data. The F-test for bank-specific characteristics reported is a joint test that the coefficients for all of the bank-specific characteristics included in the regression (1-nonperforming loans over total loans, capital over total assets, and return on assets) are jointly equal to zero. A constant is estimated but not reported. t-statistics are in brackets. *Significant at 5%, **significant at 1%, respectively.

TABLE 3

MARKET REACTION TO BANK-SPECIFIC CHARACTERISTICS AND MACROECONOMIC RISK: DEPOSIT LEVEL—URUGUAY

	Log of dollar time deposits						
	Precrisis period	Crisis period					
	Feb. 99–Dec. 00	Jan. 01–Nov. 01	Dec. 01–Jul. 02	Jan. 01–Nov. 01	Dec. 01–Jul. 02	Jan. 01–Nov. 01	Dec. 01–Jul. 02
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1 − nonperforming loans/total loans ($t-4$)	−0.36	−0.48	−2.18	−0.59	−3.75	−0.47	4.19
	[1.64]	[1.59]	[0.97]	[1.85]	[1.57]	[1.59]	[1.65]
Capital/assets ($t-4$)	1.41*	0.67	−4.39**	0.70	−3.71**	0.63	−4.89**
	[2.03]	[1.34]	[3.70]	[1.36]	[2.76]	[1.34]	[3.61]
Return on assets ($t-4$)	−0.21	−0.05	2.45	−0.30	2.71	0.11	1.98
	[0.16]	[0.05]	[1.71]	[0.31]	[1.65]	[0.11]	[1.14]
Log of assets ($t-4$)	0.46**	0.18*	0.27	0.21*	0.23	0.20*	0.80**
	[4.64]	[2.10]	[1.46]	[2.34]	[1.19]	[2.21]	[3.19]
Country risk (t)	1.51	−1.84	−5.23**	−1.03	−7.22**		
	[1.09]	[0.46]	[6.29]	[0.26]	[12.50]		
Exchange rate risk (t)	−0.08	0.79*	−1.22**			0.77*	−2.91**
	[0.17]	[2.09]	[3.89]			[2.03]	[14.40]
Total deposits in Argentina (t)	0.02**	−0.01	0.01	−0.01**	0.00	−0.01	0.02**
	[4.37]	[1.92]	[1.68]	[4.70]	[0.78]	[1.93]	[4.46]
Bank dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	602	284	197	284	197	284	197
Within R^2	0.25	0.21	0.79	0.20	0.76	0.21	0.69
F-test for bank-specific characteristics (p-value)	0.19	0.46	0.00	0.32	0.00	0.46	0.00

NOTE: This table reports fixed-effects regressions with robust standard errors of dollar time deposits on bank-specific factors and macroeconomic risk indicators. The table is based on monthly data. The F-test for bank-specific characteristics reported is a joint test that the coefficients for all of the bank-specific characteristics included in the regression (1-nonperforming loans over total loans, capital over total assets, and return on assets) are jointly equal to zero. A constant is estimated but not reported. t-statistics are in brackets. *Significant at 5%, **significant at 1%, respectively.

expected sign, or not significant, while measures of country and currency risk are never significant. By contrast, during the crisis periods, macroeconomic factors become highly significant, in some cases overshadowing the importance of bank-specific factors, as discussed below.[10]

Given the strong correlation of both macroeconomic risk indices, it is not surprising that sometimes the sign of one of them inverts and the coefficient loses significance when included together. There is, however, another reason why exchange rate risk, once country risk is controlled for, exhibits a significantly positive association with the level of dollar deposits but a significantly negative one with the level of peso deposits in the case of Argentina. The Argentine crisis entailed, in its earlier stages, a run from the currency (from peso to dollar assets) that combined with the run from domestic banks. This was certainly not the case in Uruguay, where time deposits were already almost fully dollarized.

Another key difference between the Argentine and Uruguayan cases lies in the role of Uruguay as a regional financial center that catered to foreign depositors as much as to local ones. As mentioned above, Uruguay was typically perceived as a safe haven by distressed investors in neighboring countries, particularly Argentina, which translated into portfolio inflows whenever one of these countries was threatened by a financial crisis. The latest Argentine crisis was not an exception: while Uruguayan banks ultimately felt the adverse effect of bank failures in Argentina, they did benefit from the deposit run across the border when the crisis erupted (January 2001 through November 2001), receiving deposits fleeing Argentine banks. However, the liquidity crunch caused by the imposition of the "corralito" in Argentina resulted in an increase in withdrawals from Uruguayan banks by Argentine residents. This is clearly illustrated in Table 3, where the results show how the beneficial impact of the decline in deposits in Argentina, manifested in the negative coefficient on the variable "Total Deposits in Argentina," reversed after November 2001.[11]

The fact that the explanatory power of macroeconomic factors increases significantly during crisis episodes is even more clearly illustrated in Table 4, where we compare the percentage of the within variance in deposits explained in linear models by the country and exchange rate risk variables during the precrisis and crisis periods.[12] During tranquil times, macroeconomic factors account for 2.4% and 11.9% of

10. For Uruguay, Table 3 shows that during the crisis banks with high capital ratios exhibit larger deposit withdrawals. This surprising result is driven by the two public banks in the sample (Banco Hipotecario and Banco República Oriental del Uruguay), with high capital ratios on paper but significant deposit withdrawals. In fact, there were concerns about the liquidity and solvency of these banks once the debt rating of the Uruguayan government was downgraded. In particular, Banco Hipotecario had to receive financial assistance from the central bank to deal with deposit withdrawals during the crisis. Once we exclude these banks, this unintuitive result disappears. These results are available upon request.

11. Similar results were obtained using Argentina's sovereign risk. However, given the strong trade links between the countries, Argentina's sovereign risk may have affected Uruguayan banks both (positively) through its incidence on the neighbor's financial sector and (negatively) through its adverse real impact on the local economy. In this sense, the decline of deposits lends itself to a clearer interpretation as the substitution effect between different locations.

12. The percentage of within variance explained by country and exchange rate risks is calculated as one less the within R^2 of a fixed-effects regression including only bank-specific characteristics over the within

TABLE 4

PERCENTAGE OF WITHIN VARIANCE EXPLAINED BY COUNTRY AND EXCHANGE RATE RISKS

	Argentina	
	Precrisis period	Crisis period
	Oct. 98–Jul. 00	Sep. 00–Dec. 01
Log of peso time deposits	11.86%	70.90%
Log of dollar time deposits	2.38%	76.32%

	Uruguay		
	Precrisis period	Crisis period	
	Feb. 99–Dec. 00	Jan. 01–Nov. 01	Dec. 01–Jul. 02
Log of dollar time deposits	0.81%	5.16%	56.69%

NOTE: This table shows the percentage of within variance explained by country and exchange rate risk variables, which is calculated as one less the within R^2 of a fixed-effects regression including only bank-specific characteristics over the within R^2 of a fixed-effects regression including both bank-specific characteristics and country and exchange rate risk variables. In the case of Uruguay, both regressions also include total deposits in Argentina. The table is based on monthly data.

the variance of Argentine dollar and peso deposits, respectively, while these values jump to 76.3% and 70.9% during the crisis period. In the case of Uruguay, the percentage of the within variation in dollar deposits explained by country and exchange rate risks rises from 0.8 prior to the crisis to 56.7 during the 2001–02 turmoil.

2.2 Event Studies and Dynamic Estimates Using Daily Data

While the macroeconomic variables used in the previous section explain reasonably well the evolution of deposits at a monthly frequency, it is well known that during crises financial variables tend to display extreme high-frequency volatility, which cannot be captured by monthly data. Also, specific events or news during crises are also likely to affect movements in deposits.

In this section, we use daily data to examine the incidence of macroeconomic factors (including news events) on depositor behavior. First, we adopt an event study methodology to examine the impact of macroeconomic news on deposits. We show the behavior of depositors before and after each event, and we conduct tests for differences in the mean daily change in deposits. A chronology and explanation of each news event considered in this section is shown in Table 5. For the event studies, we show figures and tests only for the main events during the crisis period to avoid reporting a large number of graphs.

Figure 2 illustrates depositor reactions to news events that surfaced during the crisis in Argentina. In particular, the figure shows the level of deposits (expressed in billions of U.S. dollars) over a window of 20 days before and after each of four news events.

R^2 of a fixed-effects regression including both bank-specific characteristics and country and exchange rate risks. In the case of Uruguay, both regressions also include total deposits in Argentina.

TABLE 5

NEWS DESCRIPTION

Argentina		
Date	News dummy value	Description
October 6, 2000	1	Vice-President Carlos Alvarez resigns.
March 16, 2001	1	The newly appointed finance minister Ricardo Lopez Murphy resigns after 2 weeks in office.
April 16, 2001	1	Domingo Cavallo, newly appointed finance minister, proposes an amendment to the convertibility law according to which the peso would be pegged to an equally weighted basket of U.S. dollars and euros.
April 25, 2001	1	The president of the central bank, Pedro Pou, resigns amid disagreements with finance minister Domingo Cavallo.
July 10, 2001	1	After being forced to pay 1,410 basis points over treasury to place a short-term bond, the government announces a zero deficit rule making clear that international capital markets are closed to Argentina.
August 21, 2001	−1	After long deliberation, the U.S. Treasury decides to support an extra loan for US$8 billion from the International Monetary Fund (IMF).
October 26, 2001	1	The negotiations toward an agreement with the provinces on the distribution of tax revenues fail (again).
October 29, 2001	1	Finance Minister Domingo Cavallo starts negotiations toward a debt exchange operation seeking support from the IMF. This exchange would be voluntary and the old debt would be exchanged for bonds paying 7% per year and guaranteed by tax revenues. The IMF and U.S. Treasury ask for compliance with the zero deficit rule and an agreement with the provinces on tax revenue sharing before giving their support for this operation.
Uruguay		
Date	News dummy value	Description
March 25, 2002	−1	The executive board of the IMF approves a new standby credit for about US$743 million, intended to support the country's economic program during 2002–04.
May 14, 2002	1	Standard & Poor's lowers Uruguay's foreign currency sovereign credit rating to BB− from BB+.
May 28, 2002	−1	IMF managing director Horst Köhler signals increased support for Uruguay, indicating his willingness to propose a significant increase in IMF financial assistance.
June 20, 2002	1	The central bank allows the peso to float, abandoning the "crawling peg" system.
June 21, 2002	1	The central bank takes control of Banco Montevideo/La Caja Obrera, Uruguay's third largest private bank, and removes its management.
June 25, 2002	−1	The IMF increases its standby credit to Uruguay by about US$1.5, to a total of US$2.3 billion.
July 10, 2002	1	Moody's lowers Uruguay's foreign currency sovereign credit rating to B1 from Ba2.
July 11, 2002	1	Finance minister Alberto Bensión is questioned by Congress amid growing political pressure.
July 19, 2002	1	Political leaders (President Battle, the president of the Partido Nacional Luis Alberto Lacalle, and Ex-President Julio Sanguinetti) agree to replace the central bank board.
July 23, 2002	1	Economy Minister Alberto Bensión resigns after losing the support of part of the ruling coalition government.
July 26, 2002	1	Standard & Poor's downgrades Uruguay's foreign currency sovereign credit rating to B.

NOTE: The news dummy takes the value 1 for bad news, −1 for good news, and 0 for no news.

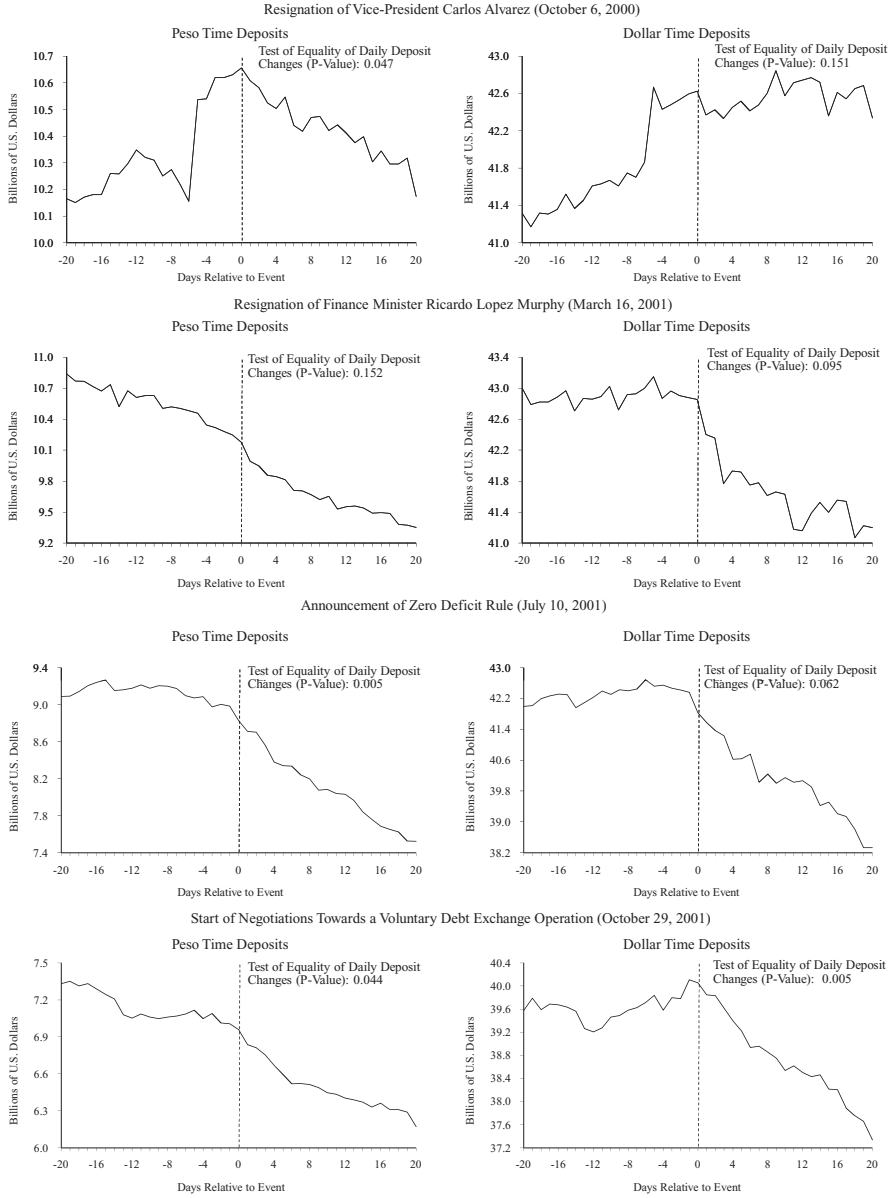

FIG. 2. Evolution of Time Deposits around Major Events—Argentina.

NOTE: This figure shows the evolution of peso and dollar time deposits around major events. The reported tests are *t*-tests of the equality of daily deposit changes before and after the event. The null hypothesis is that the mean is equal before and after the event. The alternative hypothesis is that the daily change is lower after the event. The test assumes that the variance differs across periods. For this estimation, the event window considers the date in which the event occurs and the previous day. The preevent period includes the 19 days prior to the event window and the postevent period includes the 10 days after the event.

Furthermore, this figure also shows the *t*-test for whether the mean daily change in deposits is different before and after each of these events. The plots and the corresponding tests reveal significant reductions in deposits after: (i) the resignation of Vice-President Carlos Alvarez on October 6, 2000, (ii) the resignation of Finance Minister Ricardo Lopez Murphy on March 16, 2001, (iii) the announcement of a zero deficit rule on July 10, 2001, and (iv) the start of negotiations for a debt swap on October 29, 2001.[13] This exercise is less informative in the case of Uruguay because daily deposit data are only available for this country since February 2002, resulting in the exclusion of many important events that triggered the bank run; hence, we do not show a figure for Uruguay. However, in unreported results, we find that both the announcement of the sovereign credit rating downgrade and changes made to the central bank board provoked statistically significant declines in deposits.

To complement the event study, we analyze depositor reactions to macroeconomic factors by estimating the following VAR model:

$$y_t = \alpha + \Gamma_1 y_{t-1} + \cdots + \Gamma_p y_{t-p} + \upsilon_t, \tag{2}$$

where y_t is a vector including daily systemwide deposits along with measures of country risk, exchange rate risk (only in the case of Argentina due to data availability), and a news dummy that takes the value of 1 for bad news, -1 for good news, and 0 otherwise. For Argentina, there are seven "bad" news events and one "good" news event. For Uruguay, there are eight "bad" news events and three "good" news events. $\Gamma_1 \ldots \Gamma_p$ are 3×3 parameter matrices; p is the lag length, which in our estimations goes from 1 to 10 days. Finally, α is the mean vector and υ_t is the vector of error terms.

Table 6 shows estimates based on the VAR model discussed above; it displays the responses of deposits to daily macroeconomic shocks in Argentina and Uruguay, respectively. The table shows the cumulative responses (over 20 days and 10 days for Argentina and 10 days for Uruguay) to the five largest macroeconomic innovations to each of the three variables included in the VAR.[14] The results are obtained as follows. First, after estimating the VAR model we obtain the impulse response function of deposits to each macroeconomic variable in the VAR (the measure of currency risk, the measure of country risk, and the news dummy). Impulse response functions give the reaction of deposits over a given window (20 or 10 days) to a one standard deviation change in each of the macro variables, independent of changes in the other variables. Second, we obtain the largest five "shocks" to each of the macroeconomic factors from the residuals of the different VAR equations. For example, shocks to currency

13. Whereas the resignation of Vice-President Alvarez at the early phase of the crisis triggered deposit dollarization (i.e., a decline in peso deposits at the expense of dollar deposits), the resignation of Finance Minister Lopez Murphy at a later stage fuelled a deposits run, which is in line with our narrative of the crisis with the currency run preceding the bank run.

14. For Uruguay, we consider only a 10-day cumulative response because data on daily deposits are available for a relatively short sample period, with a considerable number of events occurring very close to one another.

TABLE 6

RESPONSE OF DEPOSITS TO CRISIS SHOCKS

Argentina—20-day cumulative percentage change in deposits				
	News	Country risk	Exchange rate risk	Combined response
Percentage change in system peso time deposits	−19.18%	−11.46%	−15.47%	−46.11%
Percentage change in system dollar time deposits	−9.74%	−4.27%	−5.60%	−19.61%

Argentina—10-day cumulative percentage change in deposits				
	News	Country risk	Exchange rate risk	Combined response
Percentage change in system peso time deposits	−13.80%	−5.70%	−11.00%	−30.50%
Percentage change in system dollar time deposits	−6.30%	−2.20%	−5.50%	−14.00%

Uruguay—10-day cumulative percentage change in deposits			
	News	Country risk	Combined response
Percentage change in system dollar time deposits	−7.72%	−6.96%	−14.67%

NOTE: This table shows the cumulative (10-day and 20-day for Argentina and 10-day for Uruguay) percentage change in deposits as a response to the five largest shocks in each series. The combined response column shows the effects of shocks to news, country risk, and exchange rate risk. Combined responses are calculated by adding the percentage changes. The table is based on daily data.

risk are measured by the residuals of a regression of this variable against all other variables in the VAR. Third, using the impulse response function, we calculate the change in deposits that results from each of these large shocks. We scale the residuals by the standard deviation of each variable and multiply each by the impulse response function.[15] Fourth, because each of these shocks is by definition independent of the others, we obtain the cumulative effect of the five shocks combined by adding the impact of each of them.

Interestingly, merely 15 macroeconomic events are needed in Argentina to explain a decline of nearly 50% (30%) and 20% (14%) in peso and dollar deposits, respectively, over 20 (10) days. This represents about two-thirds and more than half of the total decline of peso and dollar deposits over the crisis period, respectively. In the case of Uruguay, the largest 10 shocks account for a decline of almost 15% of dollar deposits over a 10-day period, which represent more than one-third of the total deposit fall during the crisis. These effects, coupled with the fact that deposits tended to display very little, if any, mean reversion, provide additional support to the view that market reaction during these crises was largely driven by the evolution of macroeconomic factors.[16]

15. Residuals need to be scaled by the standard deviation of each macro variable because the impulse response function measures changes in deposits per standard deviation change in each macro variable.

16. The impulse response functions presented in the working paper version of this paper show for Argentina a large and persistent response by peso deposits to all three macroeconomic factors considered. The response of dollar deposits is smaller but also tends to be persistent. In the case of Uruguay, the response to news and country risk is fairly large. As in the case of Argentina, the drop in deposits is shown

2.3 Depositor Response to Macroeconomic Risk Exposure

The previous evidence indicating that macroeconomic factors were a key driver of deposit runs in Argentina and Uruguay suggests two additional questions regarding depositor behavior during crises. First, do depositors respond to bank-specific macroeconomic risk exposures? Second, is this exposure priced *ex ante* by depositors, at the onset of crises?

To address the first question, we follow an approach similar to that used in the literature (e.g., Saunders and Wilson 1996, Calomiris and Mason 1997) to investigate the nature of deposit runs during the 1930s. In particular, we divide our sample of banks into two groups, according to whether their exposure to macroeconomic factors is above or below the median exposure, and evaluate whether the fall in deposits during the crises is significantly larger for highly exposed banks.[17] Exposure to country (sovereign default) risk is proxied by the share of government debt (bonds and loans) over total bank assets. These data come from the central banks of Argentina and Uruguay. At the onset of the crisis period, the median exposure to country risk was 16.6% for Argentina, as of September 2000, and 3.8% for Uruguay, as of December 2001.

As mentioned above, the three alternative measures of exposure to currency risk are: the ratio of dollar loans over total bank assets, the ratio of dollar liabilities over total liabilities, and the ratio of dollar deposits to total liabilities.[18] The ratio of dollar loans over total assets accounts for the credit risk related to a currency devaluation. This measure captures the fact that, in the event of a devaluation, dollar borrowers will have difficulty repaying their loans, inflicting a loss to the bank. The median ratio of dollar loans to total assets at the onset of the crisis period was 24.3% for Argentina and 76.3% for Uruguay. The ratio of dollar liabilities over total liabilities captures those bank liabilities whose value will increase (in local currency) as a result of the devaluation. The median of this ratio at the start of the crisis period was 59.7% for Argentina and 94.1% for Uruguay. However, because not all of these liabilities (e.g., foreign loans from bank headquarters) might have to be repaid immediately, the share of dollar deposits to total liabilities might be a more appropriate measure of exposure.[19] In this case, the median at the onset of the crisis period was 37.1% for

to be persistent, suggesting that the costs of withdrawing funds (and possibly transferring them abroad, as casual evidence suggests was typically the case) made the withdrawal decision somewhat irreversible in the short run.

17. The purpose of this analysis is also similar to that in a number of studies that examine the reaction of U.S. bank stock prices to debt crises in Brazil and Mexico during the early 1980s and mid 1990s. In particular, studies such as Cornell and Shapiro (1986), Bruner and Simms (1987), Smirlock and Kaufold (1987), Musumeci and Sinkey (1990), and Karafiath, Mynatt, and Smith (1991) investigate whether the fall in stock prices was larger for banks that were heavily exposed to the country in crisis.

18. In the case of financial institutions, the traditional way of measuring exchange rate risk exposure as the difference between foreign currency assets and liabilities understates the degree of currency exposure in the event of a currency depreciation, as it ignores the embedded credit risk that arises from the dollar loans granted to debtors without dollar incomes. Indeed, the fact that all through the crisis banks in Argentina and Uruguay held a long dollar position in accounting terms did not prevent the run.

19. These ratios that focus on the liability side of banks implicitly assume that the local currency value of dollar assets remains mostly unaltered after the devaluation.

Argentina and 53.2% for Uruguay. As with the exposure measures to country risk, these ratios are calculated from balance sheet data provided by the central banks of Argentina and Uruguay.

Table 7 reports the *t*-test results for differences in the mean change of deposits across bank groups, where the group composition depends on how banks rank in terms of exposure. For all three measures of exchange rate exposure, these *t*-tests reveal that depositors do discriminate according to the bank's exposure to dollar-denominated loans and liabilities. Moreover, dividing the crisis period into an early stage and a late stage, it can be shown that, as expected, depositor response to exposure intensifies as the crisis unravels and the probability of a devaluation increases.

By contrast, differences in bank-level exposures to country risk are not significantly related to deposits, which is not surprising given that the overall exposure to the public sector was rather limited at the onset of the crisis and increased only in its later stages. Moreover, the expected consequences of a government default on the overall stability of the financial system may have dwarfed the importance of individual bank exposures.

Table 8 shows that there appears to be no systematic link between interest rates and the measures of exchange rate exposure, nor between rates and country risk exposure. Thus, macroeconomic exposure may have been perceived as relatively unimportant in tranquil times, although it had a significant effect on the quantity of deposits once problems appeared.

It should be noted that for the two sources of macroeconomic risk analyzed here, the implications of individual exposure in terms of solvency can cut both ways. Claims on the public sector are traditionally regarded as safe assets, even though they involve some sovereign risk. Similarly, dollar lending may be preferred in the presence of a sizable peso–dollar premium that increases the credit risk of peso borrowers relative to dollar borrowers, as long as the expected devaluation at the root of this "peso problem" does not materialize. A key question is whether the risks are priced *ex ante* and hence adequately compensated for or not. Although we do not find evidence of an effect on deposit rates, depositors may have been compensated in some other way, or other differences in banks' risk management practices not controlled for here may have mitigated the risk differences caused by dollar exposure.

3. MACROECONOMIC RISK AND BANK-SPECIFIC CHARACTERISTICS

As noted in the introduction, there are at least two reasons for macroeconomic risk to affect depositor behavior, independent of the bank-specific risk exposures described above. First, macroeconomic factors may signal the risk that the government may affect the repayment capacity of banks or may change the terms of the deposit contracts. This is what is commonly referred to as a "dual-agency problem" (Tirole

TABLE 7

MARKET REACTION TO BANK EXPOSURE TO MACROECONOMIC RISK: DEPOSIT CHANGE

	Argentina											
	Change in peso time deposits											
	Exposure to exchange rate risk											
	Dollar loans/assets			Dollar liabilities/total liabilities			Total dollar deposits/total liabilities			Exposure to country risk		
Period	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)
September 2000–December 2001	−73.90%	−66.68%	−7.23%* (0.05)	−76.29%	−64.29%	−12.00%** (0.00)	−77.23%	−63.35%	−13.88%** (0.00)	−67.15%	−73.43%	6.27% (0.93)
September 2000–June 2001	−14.08%	−10.25%	−3.83% (0.28)	−11.36%	−12.97%	1.61% (0.60)	−14.36%	−9.97%	−4.40% (0.26)	−14.16%	−10.17%	−3.99% (0.28)
June 2001–December 2001	−70.27%	−61.74%	−8.52%* (0.01)	−71.45%	−60.56%	−10.89%** (0.00)	−71.94%	−60.07%	−11.88%** (0.00)	−65.86%	−66.15%	0.29% (0.53)
	Change in dollar time deposits											
	Exposure to exchange rate risk											
	Dollar loans/assets			Dollar liabilities/total liabilities			Total dollar deposits/total liabilities			Exposure to country risk		
Period	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)
September 2000–December 2001	−38.71%	−37.03%	−1.68% (0.37)	−45.26%	−30.48%	−14.78%** (0.00)	−42.87%	−32.87%	−9.99%* (0.03)	−36.76%	−38.98%	2.21% (0.66)
September 2000–June 2001	4.02%	−0.27%	4.30% (0.86)	−0.83%	4.58%	−5.40% (0.09)	0.38%	3.37%	−2.99% (0.23)	2.54%	1.21%	1.34% (0.63)
June 2001–December 2001	−42.78%	−36.46%	−6.32%* (0.04)	−45.00%	−34.24%	−10.76%** (0.00)	−42.07%	−37.17%	−4.90% (0.08)	−38.14%	−41.10%	2.96% (0.80)

(*Continued*)

TABLE 7

CONTINUED

	Uruguay											
	Change in dollar time deposits											
	Exposure to exchange rate risk											
	Dollar loans/assets			Dollar liabilities/total liabilities			Dollar time deposits/total liabilities			Exposure to country risk		
Period	High exposure	Low exposure	Difference (high −low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)
January 2001–November 2001	10.99%	33.77%	−22.78% (0.16)	15.92%	28.84%	−12.92% (0.29)	2.52%	42.24%	−39.72%* (0.04)	29.57%	15.20%	14.37% (0.73)
December 2001–July 2002	−77.02%	−57.37%	−19.65%** (0.00)	−81.22%	−53.50%	−27.73%** (0.00)	−75.94%	−58.37%	−17.57%* (0.01)	−65.41%	−68.31%	2.90% (0.64)
December 2001–March 2002	−34.54%	−22.55%	−11.99%* (0.03)	−36.62%	−20.64%	−15.98%** (0.01)	−33.40%	−23.61%	−9.79% (0.07)	−26.93%	−29.80%	2.87% (0.67)
March 2002–July 2002	−65.40%	−47.48%	−17.92%* (0.01)	−72.19%	−42.58%	−29.61%** (0.00)	−62.75%	−51.30%	−11.44% (0.09)	−55.48%	−58.01%	2.54% (0.62)

NOTE: This table reports the average change in time deposits across banks with high and low exposure to macroeconomic risks. The table is based on monthly data. Banks are classified as high (low) exposure if they are above (below) the median of each exposure measure at the beginning of the period. The reported tests are *t*-tests of the equality of means across banks with high and low exposure. The null hypothesis is that the mean is equal across groups. The alternative hypothesis is that the change is larger for banks with higher exposure (i.e., they experience more outflows). The tests assume that the variance differs across groups. The *p*-values are in parentheses. *Significant at 5%, **significant at 1%, respectively.

TABLE 8

MARKET REACTION TO BANK EXPOSURE TO MACROECONOMIC RISK: INTEREST RATE LEVEL

	Argentina											
	Interest rate on peso time deposits											
	Exposure to exchange rate risk											
	Dollar loans/assets			Dollar liabilities/total liabilities			Total dollar deposits/total liabilities			Exposure to country risk		
Period	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)
September 2000	0.73%	0.74%	−0.01%	0.74%	0.72%	0.02%	0.74%	0.72%	0.03%	0.68%	0.78%	−0.10%*
			(0.76)			(0.63)			(0.53)			(0.01)
June 2001	0.95%	0.88%	0.08%	1.01%	0.80%	0.21%**	0.96%	0.87%	0.08%	0.79%	1.03%	−0.24%**
			(0.20)			(0.00)			(0.17)			(0.00)
	Interest rate on dollar time deposits											
	Exposure to exchange rate risk											
	Dollar loans/assets			Dollar liabilities/total liabilities			Total dollar deposits/total liabilities			Exposure to country risk		
Period	High exposure	Low exposure	Difference (high −low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)
September 2000	0.61%	0.63%	−0.03%	0.60%	0.64%	−0.05%	0.62%	0.62%	0.00%	0.61%	0.63%	−0.02%
			(0.42)			(0.14)			(0.97)			(0.44)
June 2001	0.66%	0.68%	−0.02%	0.66%	0.68%	−0.02%	0.68%	0.66%	0.02%	0.66%	0.69%	−0.03%
			(0.36)			(0.53)			(0.47)			(0.22)

(*Continued*)

TABLE 8
CONTINUED

	Uruguay											
	Interest rate on dollar time deposits											
	Exposure to exchange rate risk											
	Dollar loans/assets			Dollar liabilities/total liabilities			Dollar time deposits/total liabilities			Exposure to country risk		
Period	High exposure	Low exposure	Difference (high −low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)	High exposure	Low exposure	Difference (high − low)
January 2001	0.47%	0.44%	0.03%	0.48%	0.45%	0.03%	0.48%	0.44%	0.04%	0.44%	0.49%	−0.05%*
			(0.20)			(0.24)			(0.12)			(0.03)
December 2001	0.25%	0.26%	−0.01%	0.27%	0.24%	0.03%	0.27%	0.24%	0.03%	0.25%	0.26%	−0.01%
			(0.91)			(0.52)			(0.48)			(0.78)
March 2002	0.22%	0.25%	−0.04%	0.26%	0.22%	0.04%	0.24%	0.24%	0.01%	0.23%	0.25%	−0.02%
			(0.57)			(0.60)			(0.92)			(0.70)

NOTE: This table reports the interest rate on time deposits across banks with high and low exposure to macroeconomic risks. The table is based on monthly data. Banks are classified as high (low) exposure if they are above (below) the median of each variable taken with four lags. The reported tests are *t*-tests of the equality of means across banks with high and low exposure. The null hypothesis is that the mean is equal across groups. The alternative hypothesis is that the interest rate is higher for banks with higher exposure. The tests assume that the variance differs across groups. The *p*-values are in parentheses. *Significant at 5%, **significant at 1%, respectively.

2002).[20] Under this scenario, from a depositor standpoint, the probability of being repaid ceases to depend on the evolution of objective indicators of bank solvency. Though dual-agency problems are likely to be a factor behind market responses, their empirical testing is quite difficult because it is hard to distinguish it from the second channel described below.

A second explanation for the impact of macroeconomic factors on depositor behavior lies in the information content of bank-specific indicators during crises and how macroeconomic risk impacts bank-specific characteristics over time. More precisely, to the extent that bank-specific attributes are not independent from macroeconomic factors, rapidly changing aggregate innovations may detract from the predictive power of bank-specific indicators that are released at lower frequencies and with a delay. This second explanation is easier to test in the data. To see how macroeconomic factors can influence standard bank-specific variables over time, it is illustrative to consider the case of nonperforming loan ratios, which are likely to deteriorate due to the increase in borrowing costs and the downturn in economic activity associated with a macroeconomic crisis.

In particular, consider the case of a depositor who attempts to assess the future evolution of a bank's portfolio (summarized here by its nonperforming loan ratio [NPL]) over different time horizons, based on the most recently released ratio and readily available measures of macroeconomic risk.[21] Assuming, as before, that balance sheet data are released with a 4-month delay, this exercise amounts to predicting future values of the nonperforming ratio using its 4-month lag and macroeconomic risk indicators that are currently available.

We conduct this exercise by estimating regressions of the type illustrated by the following equation:

$$NPL_{i,t} = \alpha_i + \beta NPL_{i,t-j} + \gamma S_{t-k} + \varepsilon_t, \tag{3}$$

where *NPL* refers to the nonperforming loan ratio, S is a matrix of macroeconomic factors (country risk and exchange rate risk), α_i refers to the individual bank effects, and ε_t is the error term. k and j denote the number of lags in S and *NPL*, respectively, used for predicting banks' *NPL* at time t.

Since equation (3) is a dynamic panel model, the fixed effect estimator is biased. Therefore, we obtain estimates for this model using Arellano and Bond's (1991) generalized method of moments (GMM) differenced estimator.[22] Table 9 reports

20. A dual-agency problem arises when the government is a second agent (aside from bank managers), affecting banks' capacity to repay deposits. Governments can interfere directly or indirectly in private contracts, through actions that are largely beyond the control of bank managers. For example, due to "too-big-to-fail" concerns, the government may be prompted to suspend the convertibility of all deposits to protect few compromised banks. As a result, when dual-agency problems arise, depositors respond not only to bank-specific risk (disciplining bank managers) but also to the probability that macroeconomic factors erode the value of their deposits irrespective of manager behavior.

21. We focus on the ratio of nonperforming loans to total loans, since we expect this variable to reflect bank conditions better than bank capital (which can be increased at any time by bank shareholders) and return on assets (which tends to be a more volatile measure of bank performance).

22. Comparable results are obtained using simple fixed-effects panel regressions.

TABLE 9

REACTION OF NPLS TO PAST NPLS AND MACROECONOMIC RISKS: ASSUMING THAT NPLS ARE KNOWN WITH A LONGER LAG THAN MACROECONOMIC FACTORS

	Argentina Sep. 2000–Dec. 2001			
	Nonperforming loans/total loans (t)			
	$j = 4, k = 0$	$j = 8, k = 4$	$j = 4, k = 0$	$j = 8, k = 4$
Nonperforming loans/total loans ($t - j$)	−0.20	−0.39	−0.21	−0.42
	[0.59]	[0.90]	[0.64]	[0.90]
Country risk ($t - k$)	0.09	0.54*		
	[1.51]	[2.01]		
Exchange rate risk ($t - k$)			0.04	0.18*
			[1.86]	[2.16]
Number of observations	498	492	498	492
Number of banks	49	47	49	47
Hansen test of overidentifying restrictions (p-value)	0.42	0.21	0.48	0.28
Arellano-Bond AR(2) test (p-value)	0.30	0.92	0.36	0.97
Number of instruments	29	29	29	29
	Uruguay Jan. 2001–Jul. 2002			
	Nonperforming loans/total loans (t)			
	$j = 4, k = 0$	$j = 8, k = 4$	$j = 4, k = 0$	$j = 8, k = 4$
Nonperforming loans/total loans ($t - j$)	0.85	0.25	0.86	0.23
	[1.23]	[1.70]	[1.30]	[1.58]
Country risk ($t - k$)	0.21*	1.86**		
	[2.46]	[5.11]		
Exchange rate risk ($t - k$)			0.09**	0.23**
			[3.14]	[4.68]
Number of observations	459	451	459	451
Number of banks	26	26	26	26
Hansen test of overidentifying restrictions (p-value)	0.28	0.26	0.33	0.26
Arellano-Bond AR(2) test (p-value)	0.63	0.28	0.87	0.59
Number of instruments	24	24	24	24

NOTE: This table reports regressions of the nonperforming loans (NPL) ratio on its lagged values and macroeconomic risk factors, estimated using Arellano and Bond's (1991) generalized method of moments (GMM) procedure with heteroskedasticity-robust standard errors. The table is based on monthly data. The Hansen test reported is a test of overidentifying restrictions. The joint null hypothesis is that the instruments are valid (uncorrelated with the error term). The Arellano-Bond AR(2) test reported is a test of the consistency of the GMM estimator. The estimator is consistent if there is no second-order serial correlation in the error term of the first-differenced equation. The null hypothesis is that the estimator is consistent; that is, there is no second-order serial correlation in the residuals. The number of instruments reported is the number of instruments used in each regression. The z-statistics are in brackets. *Significant at 5%, **significant at 1%, respectively.

these estimates for Argentina and Uruguay for $k = 0$ and 4 and $j = 4$ and 8. Table 10 shows results assuming the same lag structure for both sources of information (i.e., for $j = k$). The findings in Table 9 present a clear and common pattern. Macroeconomic risk is a significant predictor of nonperforming loans even after controlling for its own lag, the more so the longer the time horizon, as reflected in the point estimates and standard errors. Interestingly, the informational advantage of macroeconomic factors does not rely on the fact that bank-specific characteristics are released with a lag or are stale news: the same conclusions can be drawn from Table 10. It follows that, in crisis

TABLE 10

REACTION OF NPLS TO PAST NPLS AND MACROECONOMIC RISK: ASSUMING THAT NPLS AND MACROECONOMIC FACTORS ARE KNOWN WITH THE SAME LAG

	Argentina Sep. 2000–Dec. 2001			
	Nonperforming loans/total loans (t)			
	$j = 1, k = 1$	$j = 4, k = 4$	$j = 1, k = 1$	$j = 4, k = 4$
Non-performing loans/total loans ($t - j$)	0.68**	−0.20	0.53*	−0.26
	[2.75]	[0.63]	[2.20]	[0.80]
Country risk ($t - k$)	0.05	0.52*		
	[1.19]	[2.33]		
Exchange rate risk ($t - k$)			0.04*	0.17*
			[2.43]	[2.38]
Number of observations	501	498	501	498
Number of banks	49	49	49	49
Hansen test of overidentifying restrictions (p-value)	0.44	0.52	0.40	0.52
Arellano-Bond AR(2) test (p-value)	0.31	0.43	0.33	0.38
Number of instruments	29	29	29	29
	Uruguay Jan. 2001–Jul. 2002			
	Nonperforming loans/total loans (t)			
	$j = 1, k = 1$	$j = 4, k = 4$	$j = 1, k = 1$	$j = 4, k = 4$
Nonperforming loans/total loans ($t - j$)	0.85**	1.08	0.82**	0.92
	[10.00]	[1.44]	[9.40]	[1.17]
Country risk ($t - k$)	0.19**	1.18*		
	[4.59]	[2.27]		
Exchange rate risk ($t - k$)			0.05**	0.14
			[4.73]	[1.94]
Number of observations	461	459	461	459
Number of banks	26	26	26	26
Hansen test of overidentifying restrictions (p-value)	0.31	0.27	0.27	0.28
Arellano-Bond AR(2) test (p-value)	0.73	0.93	0.80	0.85
Number of instruments	24	24	24	24

NOTE: This table reports regressions of the nonperforming loans (NPL) ratio on its lagged values and macroeconomic risk factors, estimated using Arellano and Bond's (1991) generalized method of moments (GMM) procedure with heteroskedasticity-robust standard errors. The table is based on monthly data. The Hansen test reported is a test of overidentifying restrictions. The joint null hypothesis is that the instruments are valid (uncorrelated with the error term). The Arellano-Bond AR(2) test reported is a test of the consistency of the GMM estimator. The estimator is consistent if there is no second-order serial correlation in the error term of the first-differenced equation. The null hypothesis is that the estimator is consistent; that is, there is no second-order serial correlation in the residuals. The number of instruments reported is the number of instruments used in each regression. The z-statistics are in brackets. *Significant at 5%, **significant at 1%, respectively.

periods, macroeconomic factors would contain information about future bank-specific indicators, even if bank-level indicators were known at the same time as aggregate factors.[23] Whereas the size and significance of macroeconomic risk increases with the time horizon, the coefficient on the lagged nonperforming loans ratio is almost

23. In separate evidence reported in the working paper version of this paper, we show that the percentage of the within variance of nonperforming loans explained by macroeconomic factors (in a simple linear model) increases from generally low levels in tranquil times to more than 50% in crisis periods.

never significant after controlling for country or exchange rate risk, except when we use the first lag (Table 10).

In conclusion, even if the probability of bank default could be summarized by bank-specific factors, a depositor interested in assessing this probability over the next quarter based on currently available information is expected to monitor macroeconomic variables as much as (if not more than) the latest balance sheet data released by the authorities. While measures of macroeconomic risk are likely to be stable and relatively silent about the standing of individual banks during tranquil times, they become key indicators of bank health and, for that reason, key drivers of market reaction during crises.

As one extension of these results, we investigate whether there are nonlinearities in the effect of macroeconomic factors on nonperforming loans. In particular, we interact past nonperforming loans with the macroeconomic risks to study whether banks with more nonperforming loans (weaker banks) are more affected by the macro shocks. The results, available upon request, suggest that while nonperforming loans increase across banks as macroeconomic risks rise, it would be difficult to argue that there are strong nonlinear effects. First, the interaction terms and the macroeconomic factors are highly correlated, so it is difficult to disentangle the independent effects of each variable. Second, the data cover the runup to the crises, before any actual nominal devaluation or default. Nonlinearities are more likely to appear after a devaluation or default occurs. For example, banks with higher exposure to macroeconomic risk are expected to experience larger *ex post* nonperforming loans.[24]

4. CONCLUSIONS

Using evidence from bank run episodes in two emerging economies, this paper shows that macroeconomic factors are significant drivers of depositor behavior in crisis periods, at times overshadowing the role of bank-specific characteristics. The lead role played by macroeconomic factors indicates that the information set to which market participants respond is wider than usually considered by the literature. In particular, we show the value of using bank-level measures of exposure to macroeconomic factors and of allowing for an independent impact of macroeconomic risk to understand how depositors behave.[25]

24. As another extension to the results, we added industrial production to the regressions in Tables 9 and 10 to analyze if other macroeconomic factors might be important in the evolution of bank-specific characteristics. The results suggest that the macroeconomic factors already in the paper capture well the macro risks. In other words, after controlling for country risk and exchange rate risk, the addition of a real variable like industrial production does not seem to contribute much to explaining the dynamics of nonperforming loans.

25. Borio (2003), Calomiris and Mason (2003), and Rochet (2004) call for increased attention to macro factors in banking supervision. Levy-Yeyati, Martínez Pería, and Schmukler (2004b) argue that institutional factors prevalent in emerging markets are also important when analyzing market discipline. Kane (2000) makes a similar argument referring to the importance of country-specific institutional and macroeconomic factors in affecting financial safety net design. Gennaioli, Martin, and Rossi (2009) analyze how public defaults affect banks, and ultimately credit and output.

The findings of this paper yield important lessons for the policy debate. First, the quest for market discipline, embedded in Basel II's pillar 3 and related proposals, moves in the right direction by addressing the supervisor's limitations (both in terms of human capital and as a result of agency problems) to enforce the implementation of prudential regulation. However, it faces serious shortcomings particularly in the context of emerging economies, where market reaction is often driven by macroeconomic conditions largely beyond the control of bank managers, questioning the view of market sensitivity as a disciplining device.[26] From a prudential perspective, our argument calls for a distinction between market responses to idiosyncratic and macroeconomic factors. While the former can truly discipline bank managers increasing the incentives to contain the sources of risk, the scope that managers have to restrict the latter through a reduction of their macroeconomic risk exposures is more limited.

As a second policy lesson, the finding that macroeconomic risk affects banks suggests that supervisors could play an active role in reducing exposures through prudential regulation. For example, liquid asset and provisioning requirements could take into account the denomination of bank loans. Similarly, the risk assigned to government bonds to compute capital requirements could be based on market considerations. Such simple measures to address macroeconomic exposures are typically absent from standard prudential best practices. In terms of the dynamic behavior of depositors, supervisors could monitor whether deposit flows or deposit pricing become disconnected from bank-level indicators precrisis, and whether such disconnect is due to changes in macroeconomic risk. In that case, supervisors jointly with policymakers could try to limit the effect of macroeconomic risk. Moreover, our analysis shows that the financial system can be susceptible to shocks that are unusual enough *ex ante* and seem not to be reflected in deposit rates (perhaps because depositors rely on being able to move their funds as a form of protection rather than on higher rates). This means that regulators have to be acutely aware of structural susceptibility to macro shocks and cannot expect price signals to alert them to those susceptibilities.

To conclude, much effort has been spent during recent years to strengthen banks in emerging economies. Somewhat surprisingly, however, relatively less emphasis has been placed on limiting the exposure to macroeconomic risk that can ultimately bring the whole system down. This paper contributes to fill this gap by showing empirically that a more balanced effort is indeed warranted to enhance the stability and resilience of the banking sector where macroeconomic risk prevails.

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