Review of Finance Advance Access published January 15, 2014

Review of Finance (2014) pp. 1–37
doi:10.1093/rof/rft057

Depositors' Perception of "Too-Big-to-Fail"*

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Abstract. We exploit the exogenous shock to the Brazilian banking system caused by the international turmoil of 2008 and find evidence that the run to systemically important banks is better explained by the perception of a too-big-to-fail policy than by bank fundamentals. We infer that the extra inflow of deposits received by systemically important banks during crises gives them an important competitive advantage. Our analysis also indicates that a bank's share of funding from institutional investors affects the nonfinancial firms' and institutional investors' decision to run.

JEL Classification: G21, G28, F650

1. Introduction

Governments have used substantial amounts of public resources to bail out systemically important financial institutions, usually called

* The authors gratefully acknowledge financial support from FAPESP—Fundação de Amparo à Pesquisa do Estado de Sao Paulo (The State of Sao Paulo Research Support Foundation) and Lucas Barros also gratefully acknowledges financial support from CNPq—Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development). The opinions expressed herein are those of the authors and not necessarily those of the Banco Central do Brasil (Central Bank of Brazil). We thank Franklin Allen, Heitor Almeida, Charles Calomiris, Murillo Campello, V. V. Chari, Bill B. Francis, Giacomo Nocera, Rafael Repullo, Michael Roberts, Ricardo Schechtman, and participants in the XIII Annual Inflation Targeting Seminar of the Central Bank of Brazil, 2011 European Financial Management Association Annual Meeting, and in the 2011 Brazilian Finance Meeting, seminar participants at the Wharton School—University of Pennsylvania, University of Illinois at Urbana-Champaign, FGV—São Paulo, Insper—São Paulo and Central Bank of Brazil for helpful suggestions and comments. We thank Humberto Gallucci for research assistance. Special thanks to Steven Ongena (the coeditor) and an anonymous referee whose many comments substantially improved our study. All remaining errors rest with the authors.

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"too-big-to-fail,"[1] on the grounds that their failure would cause substantial damage to the entire financial system and the rest of the economy. The existing research finds that this policy brings funding advantages in the capital markets for these systemically important banks and creates risk-shifting incentives for them and their competitors (e.g., O'Hara and Shaw, 1990; Brewer and Jagtiani, 2011; Gropp *et al.*, 2011; Dam and Koetter, 2012; Acharya *et al.*, 2013). Despite its importance, little is known about the depositor response to bailout policies. The market discipline literature finds that larger banks have higher deposit growth (e.g., Martinez Peria and Schmukler, 2001; Maechler and McDill, 2006; Bertay *et al.*, 2013). The empirical research on bank runs suggests that larger banks suffer fewer withdrawals than smaller ones (Schumacher, 2000; Schnabel, 2009). Although these studies indicate that depositors respond to too-big-to-fail policies, their contexts restrain causal interpretations.

The goal of this article is to test whether the perception of a too-big-to-fail policy affects depositors' behavior. To accomplish this task, we look for an exogenous variation in the perception of systemic uncertainty that is strong enough to motivate an unexpected and abrupt shift in depositor behavior. We use the international financial crisis that triggered a depositor run in Brazil—in which small and medium banks lost approximately 20% of their certificates of deposits (CDs) to the big banks from mid-September 2008 until the beginning of January 2009—and examine whether this depositor behavior is better explained by bank fundamentals or by the perception of an implicit governmental guarantee for systemically important banks.

The focus on Brazil aids our identification because before the crisis its banks had been performing well and had very low exposure to the foreign capital markets. The economy had been showing record of high growth and the housing market was not a concern.

In addition, among countries where the financial sector was not exposed to subprime-related assets, Brazil has a unique blend of market and institutional features that are useful for the identification of a too-big-to-fail effect. First, the residents can choose to make deposits in banks that are privately or state-owned, domestic or foreign subsidiaries, large, medium, or small. This wide range of options allows for a greater potential variation in the depositor reaction to the crisis than in countries with a less diversified financial sector. Second, the deposit insurance coverage remained the same limited amount per depositor per financial conglomerate (60 thousand BRL,

[1] We use the term "too-big-to-fail," although it should be understood in the broader meaning of systemic importance.

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approximately 30 thousand USD at the time) throughout the crisis,[2] unlike in other places such as Australia, New Zealand, and Hong Kong, for example, which introduced generous deposit guarantees to avoid pressure on the banks and to restore depositors' confidence. As Ioannidou and Penas (2010) show, the too-big-to-fail effect may be sensitive to changes in deposit insurance. Third, Brazilian residents cannot hold deposits in foreign currency, unlike in many other countries, such as Singapore, Canada, and Israel. Distinguishing a too-big-to-fail effect is harder in these countries because the shifts in deposits can be motivated by currency substitution rather than by the fear of bank failure. Fourth, CDs may be withdrawn at any time (sometimes at a penalty rate), regardless of the nominal maturity. This *de facto* liquidity is a Brazilian market practice, stemming from Brazil's history of macroeconomic turbulence and high volatility (Mesquita and Toros, 2010). Thus, deposits can shift more quickly than in developed economies.

Additionally, along the lines of Ayar (2012), Gormley (2010), and Calomiris and Mason (2003), by focusing on one country, instead of cross-country comparisons, we are able to control for the effects of the macroeconomic environment, the type of deposit insurance scheme, the currency in which deposits can be made, and other unobservable microeconomic sources of heterogeneity that might otherwise confound our analysis.

The final advantage of analyzing Brazil is that the Central Bank of Brazil provided a unique dataset including detailed bank-level information disaggregated by deposit-size categories and type of holder of CDs: institutional investors,[3] nonfinancial firms, and individual investors. We also use data from the mutual funds' portfolio holdings of CDs to further investigate the behavior of institutional investors. To the best of our knowledge, this is the first article employing disaggregated data that allows for a finer understanding of the differences in behavior by the type of depositor. The dataset also includes the interest rates paid on freshly issued CDs. These marginal rates capture the dynamic interaction of deposit interest rates and deposit

[2] In the case of Brazil, only in March 26, 2009—near the end of the crisis—were banks authorized to issue a new type of bank liability, with a special guarantee of 20 million BRL (equivalent to approximately 9 million USD at the time), as long as they complied with a specific set of rules. These special-type liabilities are excluded from our database, so our 2009 findings are unaffected by this additional deposit guarantee. Nonetheless, to put this change into perspective, these special-type liabilities represent 1% of the total deposits in the Brazilian banking system and 8% of the total deposits of small and medium banks by the end of the sample period in December 2009.

[3] Institutional investors are investment funds, investment companies, pension funds, and insurance companies.

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quantities better than the implicit interest rates, which are computed in previous papers as the ratio of interest expenses to the level of deposits (e.g., Martinez Peria and Schmukler, 2001; Maechler and McDill, 2006; Acharya and Mora, 2013).

To identify the systemically important banks (big banks, for short), we apply a cluster analysis based on the institutional characteristics—such as leverage, size, and maturity mismatch—found by Adrian and Brunnermeier (2011) to predict their measure of future systemic risk importance (forward-ΔCoVaR). Alternatively, we use variables that capture different aspects of size and find identical clusters. Our inferences are also robust to including the subsidiaries of the global powerhouse banks that are not locally systemically important.

The results from our analysis indicate that the run to the big banks during the international turmoil is better explained by the depositors' perception of an implicit too-big-to-fail policy and that the depositors' response to economic fundamentals is a second-order effect. The big banks receive an economically large excess inflow of uninsured and total deposits relative to other banks during the crisis. We find an expected increase of approximately 41 (33) percentage points (pp) in uninsured (total) deposits for the big banks relative to the other banks during the crisis. Institutional investors and nonfinancial firms are the primary types of CD holders that flee to big banks during the crisis. We find an expected increase of approximately 68 (43) pp in the growth rate of CDs issued by big banks to institutional investors (nonfinancial firms) relative to those issued by other banks.

To further investigate the behavior of institutional investors, we look at the portfolios of fixed income investment funds and find that fund managers increase their allocation in the CDs of the big banks and reduce their allocation in the CDs of small and medium banks during the crisis. For funds that held both types of CDs prior to the crisis, the expected difference between the holdings of CDs of big banks and CDs of other banks, scaled by total assets, increases by approximately 8 pp during the crisis. This evidence is consistent with our bank-level results.

Our analysis indicates that the banks that have a higher share of CDs held by institutional investors before the crisis suffer more outflows from nonfinancial firms and institutional investors throughout the crisis. A 1 pp increase in the share of institutional investors is expected to decrease the growth in CDs held by nonfinancial firms (institutional investors) by approximately 1.9 (5.7) pp during the crisis.

We run a battery of tests to check the robustness of our results to the banks' ratings, measures of diversification and operating efficiency and also to the inclusion of bank-specific risk factors that capture possible

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transmission channels of the international turmoil to the Brazilian economy, among others. All our findings remain robust to alternative specifications.

Our finding that fundamental risk factors play a minor role differs from previous studies in which runs are based on bank fundamentals (e.g., Schumacher, 2000; Calomiris and Mason, 2003; and Schnabel, 2009), but they are consistent with the most recent evidence. For example, Hassan *et al.* (2012) analyze data from 416 banks in 11 Central European countries and find that depositors respond to press rumors instead of bank fundamentals during the 2007–09 crisis. Correa *et al.* (2012) study a run on deposits of US branches of European banks during the European sovereign debt crisis in 2011 and find evidence that depositors (especially US money market funds) withdraw from euro-area branches in a rapid and somewhat indiscriminate way, without differentiating according to the parent banks' holdings of risky sovereign debt. Iyer *et al.* (2013) examine a run on an insolvent bank and find that withdrawals are based on regulatory signals regarding bank solvency, and not so much on depositors' own monitoring of bank fundamentals. Brown *et al.* (2013) survey Swiss retail depositors and find that a major motivation for households to withdraw from two large and distressed Swiss banks during the crisis is anger over their corporate policies, and not fear that their deposits were at risk. Our results are also related to the evidence of a panic-run from a bank in India found by Iyer and Puri (2012).

Our finding that institutional investors run heavily to the big banks during the crisis is related to the wholesale funding literature. The model of Huang and Ratnovski (2011) shows that short-term wholesale financiers prefer to rely on costless but noisy public signals (e.g., the performance of other banks or market indicators) rather than to perform costly bank monitoring, triggering inefficient liquidations. Additionally, Ben-David *et al.* (2012) argue that institutional investors are more reactive to bad news than individual investors because they have internal risk-management systems or funding requirements that may force a periodic revision of their asset allocation. Our evidence is similar to the findings of Schmidt *et al.* (2013), who analyze the US money market fund crisis in September 2008 and find that institutional investors moved their money more quickly than retail investors. Our finding that a bank's share of funding from institutional investors affects the nonfinancial firms' and institutional investors' decision to run is consistent with the findings of Ben-David *et al.* (2012)—in which hedge funds with a higher share of institutional investors experience stronger redemptions during a crisis—and may indicate the presence of strategic complementarities; i.e., nonfinancial firms and institutional investors fear that massive outflows from institutional investors can harm the bank's health and decide to withdraw.

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Our article contributes to the literature on the effects of government guarantees by showing that depositors favor systemically important banks in turbulent times even in the absence of an explicit too-big-to-fail policy. In this sense, our study provides evidence for the effects of the time-inconsistency problem faced by central banks, as discussed in Chari and Kehoe (2013).

Our article adds to the literature on liquidity production and liquidity-risk management. On the one hand, some studies (e.g., Kashyap *et al.*, 2002; Gatev and Strahan, 2006; Gatev *et al.*, 2009; and Cornett *et al.*, 2011) find that investors move their funds into banks in periods of tight market liquidity and then banks use these funds to meet loan demand from borrowers. On the other hand, Acharya and Mora (2013) argue that US banks had to offer higher deposit rates to attract deposits in the recent crisis, weakening the safe haven theory of deposits and the role of the banking system as a stabilizing liquidity insurer. Our evidence adds a nuance to both strands of the literature: we find that investors shift their resources to systemically important banks, leaving the other banks heavily liquidity constrained. We also find that the big banks did not actively seek deposits by raising rates. Thus, systemically important banks have a competitive advantage in the form of extra access to market liquidity from depositors. This evidence adds another layer to the discussions about bank competition and financial stability.

Our article also speaks to the literature on international transmission mechanisms. Studies by Popov and Udell (2012), Schnabl (2012), and Cetorelli and Goldberg (2012) find that international crises negatively affect domestic lending. We add evidence that international crises impact the depositors' allocation decisions in the domestic banking system.

The remainder of the article proceeds as follows. Section 2 describes the motivation for our study and the theoretical foundation. Section 3 introduces the empirical strategy. Section 4 provides the institutional details and describes the data and the sample selection. Section 5 presents the results and provides some robustness checks. Section 6 presents the results of the analysis at the fund level, and Section 7 concludes the article.

2. The Global Crisis and the Run

Allen and Carletti (2010) argue that the most disruptive consequence of Lehman's failure was the signal that it sent to the international markets, raising concerns about the solvency and liquidity of financial institutions. The difficulty of distinguishing between solvent and insolvent banks—or the

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inability to precisely anticipate the level of government support—made depositors uneasy. In response, the USA and many European countries extended deposit insurance coverage or introduced blanket guarantees (Laeven and Valencia, 2010). In October 10, 2008, the G-7 issued an action plan that included a pledge to save systemically important financial institutions.

Excerpts from an interview with Mário Torós, then the Central Bank of Brazil Deputy Governor for Monetary Policy,[4] illustrate the events that took place during the worst period of the crisis:

> We heard stories of people [in other countries] withdrawing money from Chase Manhattan to buy gold. In Brazil, it was something minor. The big [banks] were little or not affected. The problem was with the small and medium [banks]. [...] Our supervision department had a good look at these banks' balance sheets. Unlike what was happening abroad, they had solid loan portfolios. [...] Everything happened very fast. [...] We threw money from a helicopter to fight the liquidity crisis.

The run in Brazil was specific to small and medium banks, as the overall deposit base grew by approximately 30% during the second half of 2008. The Central Bank of Brazil took several measures to provide liquidity to these banks, such as reducing reserve requirements and changing the structure of the discount window.[5] Because small banks are generally exempt from requirements, the Central Bank designed the measures to reduce reserve requirements so as to spread the excess liquidity of the big banks to the small banks. Specifically, the condition for releasing reserves was that they be used to provide interbank loans, to buy illiquid loan portfolios or to buy other assets from banks that had equity lower than 7 billion BRL.

Figure 1 shows the evolution of the CDs of big banks and the other banks and a timeline of the liquidity measures, spanning from September 12, 2008 to June 30, 2009. The run from the other banks to the big banks starts 9 days

[4] The article was published on November 13, 2009, in a top business newspaper, Valor Econômico, under the title "Brasil enfrentou ataque e corrida bancária na crise" ("Brazil faced a [speculative] attack and bank run during the crisis").

[5] The measures to reduce reserve requirements occurred on the following dates in 2008: September 24; October 2, 8, 13, 14, 15, 24, and 30; November 13 and 25; and December 19. The measures to change the structure of the discount window occurred on October 6, 9, 10, and 16. The phasing out of the measures that reduced reserve requirements started on February 24, 2010 (outside of our sample period), taking back approximately 70% of the amount released in the second half of 2008 (BCB Financial Stability Report April 2010, p. 16). According to Mesquita and Torós (2010, p. 118), "the discount window was not used during the crisis, as banks feared the stigma effect."

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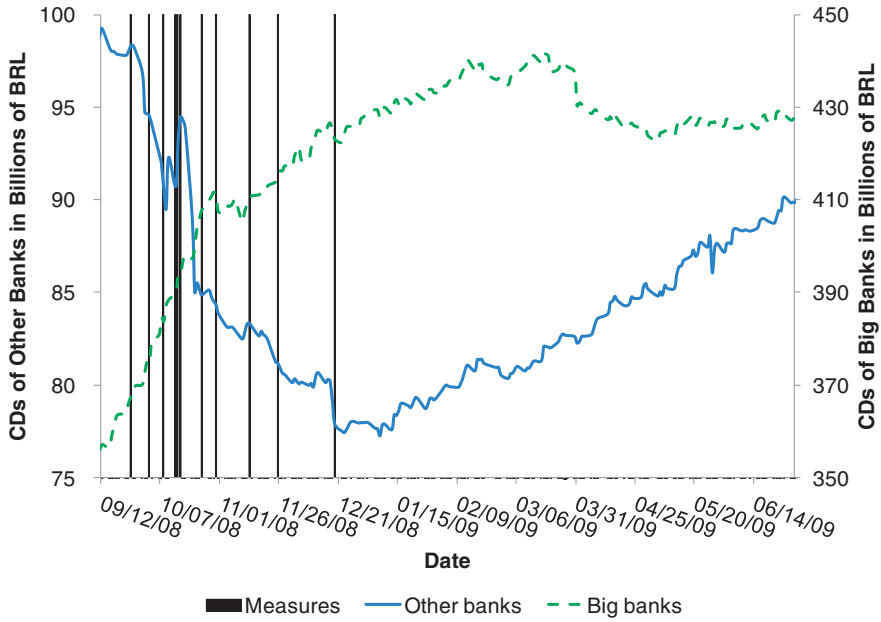

Figure 1. Evolution of the CDs. The solid line is the daily evolution of the amount of CDs of the banks that are not considered systemically important in Brazil (other banks), shown on the left vertical axis. The dashed line is the daily evolution of the amount of CDs of the big banks (systemically important), shown on the right vertical axis. The solid vertical lines show the dates of the reserve requirements measures. The big banks and the other banks are defined in Table I (Panel A).

before the first reserve requirement reduction. The other banks' deposits start increasing again in early January 2009. The deposit growth rate of the big banks slows down at the same time and reverts to deposit decrease in early March 2009.

One concern with this policy response is that the reductions in reserve requirements could yield a confounding effect if they led the big banks to actively manage deposit rates to attract funding inflows. This effect could potentially lead to an upward bias in our estimation of the too-big-to-fail effect. We believe this is not the case for two reasons: (i) small and medium banks pay a higher mean interest rate on freshly issued CDs than the big banks before the crisis and this difference widens during the crisis, and (ii) we use the interest rates paid on freshly issued CDs as a control variable, which allows us to capture the dynamic interaction of deposit interest rates and deposit quantities.

Other pieces of evidence indicate that the reduction in deposits of the other banks is driven by a deposit supply effect: the total loans extended by the

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other banks increase by 1.4% during the second half of 2008 and the median rate paid by the other banks in the interbank market increases 118 basis points during the crisis, whereas the median rate paid by the big banks decreases 177 basis points. These figures suggest that the other banks borrow from the interbank markets to replace the loss of deposits instead of shrinking their loan portfolios. Two main arguments may explain why depositors run from the other banks to the big banks.[6] One is that the run is fundamental based, meaning that the depositors perceive the other banks as having weaker fundamentals than the big banks. Alternatively, if the information asymmetry regarding impending bank distress lies behind the run, coupled with the observation of many small and medium banks failing and of systemically important financial institutions being bailed out in the USA and Europe, then the run is panic based. Panic-based theories argue that depositors withdraw funds without proper assessment of bank fundamentals (Chari and Jagannathan, 1988; Jacklin and Bhattacharya, 1988; Chen, 1999; Chen and Hassan, 2008). Together with the perception of a too-big-to-fail policy, this context led depositors to run to the big banks. Both possibilities are discussed in greater detail in Section 3.

The behavior of the stock markets parallels that of the deposit markets. In particular, the stocks of small and medium banks plunge as they start losing deposits. Figure 2 shows the cumulative abnormal returns (CARs),[7] starting on September 15th, 2008, of two equally weighted portfolios: one with the stocks of the four publicly traded big banks and the other with the stocks of the other 15 traded banks. The portfolio of the big banks experienced a positive CAR of 10% during the 4 weeks that followed Lehman's failure, while the CAR for the portfolio of the other (nonbig) publicly traded banks was −23%. These differences in returns are not driven by differences in stock liquidity, as we check the average number of daily trades for the stocks of both big banks and other banks and find no significant difference between the precrisis, crisis, and postcrisis periods. The portfolio of the other banks starts to recover in January 2009, coinciding with the recovery in deposits depicted in Figure 1.

The adoption of a too-big-to-fail policy may also be inferred from the country's recent history. After the inflation stabilized in 1994, several banks were unable to adjust to the new environment and became distressed.

[6] Allen *et al.* (2009) and Laeven (2011) provide excellent surveys of the literature of bank runs.

[7] The CAR is computed over the Ibovespa Index, the most commonly used stock market indicator in Brazil.

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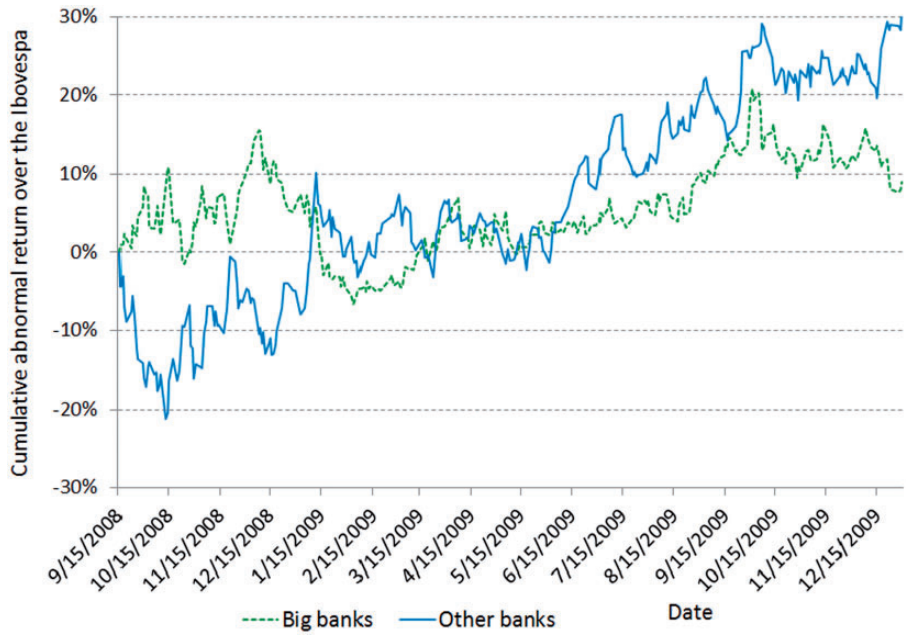

Figure 2. CARs over the Ibovespa Index. The dashed line is the CAR of the equally weighted portfolio of stocks of the four publicly listed big banks in Brazil. The solid line is the CAR of the equally weighted portfolio of stocks of the fifteen publicly listed other banks in Brazil, starting on September 15, 2008. We compute the Abnormal Return of portfolio p in date t as follows: $AR_{p,t} = R_{p,t} - R_{Ibovespa,t}$, where $R_{p,t}$ is the cumulative return of portfolio p in day t and $R_{Ibovespa,t}$ is the return of Ibovespa on day t. We then cumulate these daily abnormal returns to obtain the CAR of each portfolio.

To address the fragility of the banking system, the Brazilian government launched three major official bank restructuring programs, including government capital injections to the systemically important private and state-owned banks. In contrast, small private and state-owned banks were allowed to fail.

The mid-1990s crisis responses may have influenced the depositors' perception of government guarantees for the big banks, as there are two turbulent events other than the global financial crisis in which depositor behavior is seen to be consistent with a preference for big banks. The first event is the election of Lula da Silva in 2002, which sparked fears of radical leftist reforms. The second is the failure of Banco Santos in November 2004 (the only bank failure within our sample period), which increased the perception of riskiness for similar small and medium banks (Ahmar, 2006).

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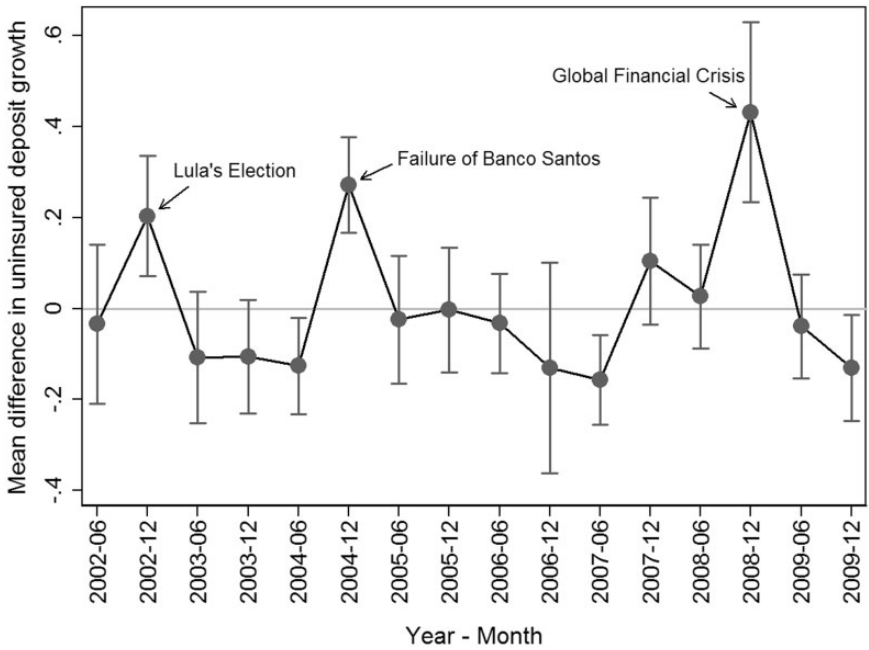

Figure 3. Mean difference in uninsured deposit growth between the big banks and the other banks. This figure shows the mean difference in the growth rate of uninsured deposits between big banks and other banks conditional on each time period. The bars represent 95% confidence intervals and are computed using the "margins" command in Stata. The estimates are derived from an ordinary least squares (OLS) regression with no controls using bank-clustered standard errors.

Figure 3 illustrates this depositor behavior by showing the mean difference in the growth rate of uninsured deposits between big banks and other banks conditional on each time period. The estimated growth rate differential is reliably positive and economically significant during the three events. Unlike the global financial crisis, the election and the bank failure events are closely connected to forces that are endogenous to the functioning of the local economy and the financial system, making it harder to identify the too-big-to-fail effect.

3. Identification and Empirical Strategy

To examine the extent to which depositor behavior is affected by bank fundamentals or the perception of a too-big-to-fail policy, we exploit the exogenous variation in the perception of systemic uncertainty caused by the international financial turmoil by using a discontinuity approach.

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We estimate the following model:

$$\begin{aligned}\Delta\text{Deposits}_{i,t} = {} & \alpha + \omega\left(\text{Big Bank}_i \times \text{Crisis}_t\right) + \vartheta\text{Crisis}_t + \gamma\text{Big Bank}_i \\ & + \beta'\text{Fundamentals}_{i,t-1} + \tau'\left(\text{Fundamentals}_{i,t-1} \times \text{Crisis}_t\right) \\ & + \theta\text{Size}_{i,t} + \lambda\Delta\text{Interest Rate Margin}_{i,t} + \phi\Delta\text{Deposits}_{i,t-1} \\ & + \delta\Delta\text{Regional Economic Activity}_{i,t} + \mu_i + d_t + \varepsilon_{i,t}\end{aligned} \tag{1}$$

The dependent variable is the semiannual change in the deposits of bank i in period t, defined as the first difference of the log of deposits between $t-1$ and t.

The effect of the perception of a too-big-to-fail policy on depositor behavior is captured by the coefficient ω of the interaction between crisis and big bank. The crisis indicator is a time dummy, and we give it special attention because it marks the period of international turmoil. The international turmoil starts in September 2008 and ends by the G20 Leaders' Summit on Financial Markets and the World Economy in April 2, 2009 (Aït-Sahalia *et al.*, 2012). Because the dataset is available only on a semiannual basis, our definition of the crisis period is bound to the second half of 2008. The big bank variable is an indicator that equals 1 for the banks that are defined as systemically important in Section 3.1.

We include a vector of the bank fundamentals that are traditionally found in the literature (fundamentals) to account for the information-based (or fundamental-based) approach to bank runs and depositor discipline. This vector includes the variables equity ratio, defined as the ratio of equity to total assets, to measure capital adequacy; low-quality loans, defined as the ratio of low-quality loans to total assets,[8] to measure the risk of the loan portfolio; and asset liquidity, defined as the ratio of liquid assets (cash, tradable securities, and net interbank) to total assets, to measure liquidity risk. We also add their interactions with the crisis indicator.

The variable size, defined as the natural logarithm of assets, controls for the other features continuously related to bank size that may be seen as beneficial to depositors. For instance, larger banks are usually more diversified, either because they have a large customer base or because they offer a wide array of financial services and products. There can be other

[8] Brazilian banks must rate their credit operations by risk category, namely, AA, A, B, C, D, E, F, G and H, and report the volume of credit in each of these ratings. Low-quality loans are those that fall within the E to H ratings. Resolution 2,682 from the Brazilian National Monetary Council states that loans 90 days overdue or more should be rated E or worse.

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features that are considered to be beneficial, such as the depositors' perception that the larger banks have cutting-edge technology and better risk-management techniques.

Building on Maechler and McDill (2006) and Acharya and Mora (2013), we include in the model the variable Δinterest rate margin, defined as the semiannual change in the difference between the interest rate paid on the CDs issued by each bank in each period and the Brazilian reference rate Selic.

The lagged dependent variable $\Delta\text{deposits}_{i,t-1}$ accounts for possible momentum or mean reversion effects in the dynamics of the change in deposits. We also include a set of time dummies, represented by d_t, to account for time-fixed effects, enabling us to control for the common effect of any shock to $\Delta\text{deposits}_{i,t}$ during time t. In addition, we include a proxy for the regional economic activity (Δregional economic activity), defined as the change in the retail sales index of the state in which the bank has the most branches, to control for heterogeneous macro-effects over the depositor base. Bank unobserved fixed effects are represented by μ_i and ε is the error term.[9]

The models are estimated using the system generalized method of moments (GMM-Sys), described by Blundell and Bond (1998).[10] The GMM-Sys allows us to estimate dynamic panel models that account for the presence of bank fixed effects and control for any time-invariant unobserved features that might influence the change in deposits. In addition, the GMM-Sys enables us to mitigate concerns over the plausibly endogenous relationship between the change in deposits and some of the regressors by using suitable lagged values of the regressors as instrumental variables. For example, because deposit interest rates and deposit quantities are jointly determined, we allow Δinterest rate margin to be correlated with contemporaneous values (as well as with past values) of the error term ε, but not with future values of ε. Under this identifying assumption, we can use appropriate lags of Δinterest rate margin as instruments. Analogously, we

[9] Because the amount covered by deposit insurance was extended from 20 to 60 thousand BRL (approximately 27 thousand USD at the time) in August 2006—a calm period for the Brazilian banking system—we include a deterministic regressor that assumes the value of the change in uninsured (insured) deposits resulting from the extension of coverage in the model with the uninsured (insured) deposits on the left-hand side as of December 2006 and zero otherwise. This variation cannot be captured by time-fixed effects because the change in coverage affects each bank differently depending on the number of depositors and the volume of deposits in several different deposit-size categories.

[10] We also provide the results of the estimations using pooled OLS in the Supplementary Appendix. The coefficients of interest differ only marginally relative to the GMM estimations reported in Section 5.

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allow bank fundamentals and size to be correlated with past shocks to account for feedback effects running from the change in deposits to those variables.

To understand whether depositors behave differently depending on whether their funds are insured, we estimate Equation (1) with changes in the uninsured and insured deposits on the left-hand side. Deposit insurance is mandatory and provided by the Brazilian Deposit Insurance Fund (Fundo Garantidor de Crédito—FGC, in Portuguese); the fund is financed by flat insurance premiums paid by every deposit-taking institution. Because total deposits are the sum of uninsured and insured deposits, we omit the estimation of the model with insured deposits on the left-hand side.

We also examine the potential differences in behavior by the type of depositor by estimating Equation (1) with changes in the CDs held by institutional investors, nonfinancial firms, and individual investors on the left-hand side.

3.1 BIG BANKS

The recent literature's definition of systemic importance goes beyond asset size. The quantitative models that aim to estimate the individual banks' contributions to systemic risk usually rely on stock market data. Because only nineteen banks in Brazil were publicly traded in 2008, we resort to bank characteristics to identify those that are systemically important. To accomplish this task, we build on Adrian and Brunnermeier (2011), who develop a systemic risk indicator based on market data (ΔCoVaR) and relate it to the financial institutions' characteristics. Adrian and Brunnermeier (2011) find that financial institutions with higher leverage, greater maturity mismatch, and larger size tend to be associated with larger systemic risk contributions between one-quarter and 2 years later.

We use the same variables suggested by Adrian and Brunnermeier (2011) in several cluster analyses to differentiate between the two sets of banks: the systemically important banks and the others. We use data from the beginning of the sample period until the period prior to the global financial crisis to make this differentiation. The variables are as follows: (i) leverage, defined as total assets/total equity (in book values); (ii) size, defined as the book value of total assets; (iii) loan-loss reserves/total book assets; (iv) trading assets/total book assets; and (v) noninterest-bearing deposits.

Table I (Panel A) shows the two-cluster classification suggested by two clustering algorithms, *K-means* and *K-medians* (see Kaufman and Rousseeuw, 2005). The first cluster is composed of eight banks that are

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Table I. Systemically important banks

Panel A shows the results of the cluster analysis algorithms *K-means* and *K-medians*, setting the number of clusters to $k = 2$. Five variables were used for the clustering: (i) leverage, (ii) total assets, (iii) loan-loss reserves/total assets, (iv) trading assets/total assets, and (v) noninterest bearing deposits. The algorithms search iteratively for the best partition using the squared Euclidean distance as the dissimilarity measure. We use only precrisis data from December 2001 through June 2008. Cluster 1 includes banks that may be considered systemically important in Brazil, whereas cluster 2 includes all the other banks in the sample. Panel B shows an alternative specification, which splits banks that are big in Brazil into banks controlled by domestic and foreign shareholders, and includes another category, which is the set of systemically important banks the subsidiaries of global systemically important banks that are not big in Brazil (global powerhouse banks), based on a list published by the *Financial Times* (Jenkins and Davies, 2009).

Cluster	Bank
Panel A—Baseline specification: big banks (results from the cluster analysis)	
Cluster 1 (Big Banks)	ABN AMRO, Banco do Brasil, Bradesco, CEF, HSBC, Itau, Santander, Unibanco
Cluster 2 (Other Banks)	ABC-Brasil, Alfa, Bancoob, Banese, Banestes, Banif, Banpara, Banrisul, Bansicredi, Basa, BBM, Besc, BGN, BIC, BMG, BNB, BNP Paribas, Bonsucesso, Brascan, BRB, BTMUB, BVA, Citibank, Credit Suisse, Cruzeiro do Sul, Daycoval, DBB BM, Deutsche, Fibra, Ibibank, Industrial do Brasil, Indusval, ING, J. Malucelli, John Deere, JP Morgan Chase, Mercantil do Brasil, Nossa Caixa, SS, Pine, Prosper, Rabobank, Rural, Safra, Schahin, SMBC, Societé Générale, Sofisa, Pactual, Votorantim, WestLB
Panel B—Alternative specification: big banks + global powerhouse banks	
Big Domestic Banks	Banco do Brasil, Bradesco, CEF, Itau, Unibanco.
Big Foreign Banks	ABN AMRO, HSBC, Santander
Global Powerhouse Banks that were not clustered as Big Banks	BNP Paribas, BTMUB (Tokyo-Mitsubishi), Citibank, Credit Suisse, Deutsche, ING, JP Morgan Chase, SMBC (Sumitomo Mitsui), Societé Générale.

remarkably different (in terms of the five variables that we employ) from the remaining banks. The result is the same using both algorithms.

We check the robustness of our categorization using bank size as the driver of systemic importance, similar to the studies by Brewer and Jagtiani (2011), Bertay *et al.* (2013), Houston *et al.* (2010), and Laeven and Levine (2009). Size is easily observed by the market and has historically been the only feature used to distinguish the institutions that pose systemic risk. Our approach is to run additional cluster analyses using variables that capture different aspects of size: (i) total book assets plus brokerage, (ii) total book assets, (iii) total deposits, (iv) number of branches, and (v) number

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of clients. We find that the set of systemically important banks shown in Table I remains unchanged by this further analysis.

In addition, we investigate the role of expected Brazilian and foreign government support and check if depositors differentiate among the domestically owned big banks, the foreign-owned big banks, and the subsidiaries of global systemically important institutions that do not fit the aforementioned big bank criteria (global powerhouse banks). This issue is relevant because Ongena and Penas (2009) find abnormal bond returns for domestic bank mergers but not for international mergers within the EU, an indication that the too-big-to-fail effect is larger for banks that are systemically important within a given country rather than internationally or that a bailout is simpler when no coordination is needed among regulators. We split the set of big banks into two subsets (domestic big banks and foreign big banks) and create a dummy variable assuming 1 for the global powerhouse banks and 0 otherwise. The set of global powerhouse banks, shown in Table I (Panel B), is based on a list published by the *Financial Times* (Jenkins and Davies, 2009) and includes nine banks.

All of these previous criteria use a binary definition of systemic importance. We also develop a more granular measure using a procedure similar to Gropp *et al.* (2011), i.e., assigning bailout probabilities to our sample banks based on their support ratings, rating floors, and state ownership. This procedure is detailed in the Supplementary Appendix.

4. Data, Summary Statistics, and Mean Comparison Tests

Our primary database consists of observations of deposit-taking banks in Brazil from December 2001 to December 2009. In cases where the banks belong to a common holding company, we use information from the holding company-level balance sheets, following Gatev and Strahan (2006).

There are just over 100 banks in Brazil and they can be separated into three different types according to ownership structure: domestic privately owned banks, foreign subsidiaries, and state-owned banks (owned by either the federal or state government). All the banks are regulated and supervised exclusively at the federal level by the Central Bank of Brazil. In the period immediately before the crisis, domestic private banks and subsidiaries of foreign banks held approximately 57% of the total deposits in the system, whereas state-owned banks held the remaining 43%. The banks' funding structure is primarily deposit based and the average loan-deposit ratio in the precrisis period was approximately 0.9. A detailed description of the composition of deposits by bank ownership type and through time can be found in the Supplementary Appendix.

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Our data come from five different sources. The first set of data is available to the public on the Central Bank of Brazil website. This dataset is composed of detailed balance sheets, income and earnings reports, as well as data on the number and location of branches and regulatory indicators.

The second source for our data is private and comes from the Brazilian Deposit Insurance Fund. These data allow us to compute the volume of the insured and uninsured deposits of each bank in each period. Third, we use private data provided by the Central Bank of Brazil. This novel dataset includes the daily balances of CD held by institutional investors, nonfinancial firms and individual investors as well as the interest rates paid on issues of fresh CDs. The dataset also includes semiannual information on the different types of outstanding bank loans.

Fourth, we use data from the retail sales index provided by the Brazilian Institute of Geography and Statistics (IBGE is its acronym in Portuguese), which measures the growth in retail sales for each of the twenty-seven states of the federation as well as the resulting national growth in retail sales.[11] This index is the most commonly used indicator of regional economic activity.

We exclude from our sample the banks whose ratio of deposits to assets is lower than 1% to analyze only banks that take deposits on a regular basis. We also exclude the banks that were under Central Bank intervention and the banks that were not among the top fifty in either deposit taking or total assets in any of the seventeen periods. The banks in our sample hold almost 98% of the deposits in the Brazilian banking system. We require that all observations have nonmissing data for book assets, and all multivariate analyses implicitly require nonmissing data for the relevant variables. To mitigate the impact of data errors and outliers on our analysis, we Winsorize all variables at the 5th and 95th percentiles. We treat merged banks (or acquisitions in which two different banks consolidate their balance sheets) as new banking entities.[12] At the beginning of the sample period, the sample has seventy-three banks, which hold 97.1% of the total deposits in the Brazilian financial system. At the end of the sample period, we have fifty-two banks, which hold 99% of the total amount of deposits. The decreasing number of banks is the result of mergers and acquisitions

[11] Although interstate branching is allowed, many banks concentrate activities in specific states. If a bank has branches in more than ten states and no single state accounts for more than 50% of its branches, we consider it to be a nationwide bank and use the national index. Otherwise, we use the index for the state where the bank has the most branches.

[12] For example, if Bank A acquires or merges with Bank B, we treat the merged Bank A + B as a new bank. In this case, the change in deposits is calculated based on the sum of the deposits of the two merged banks. In the Supplementary Appendix, we address the possibility of nonrandom sample attrition.

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throughout the sample period and of one bank failure, which occurred in 2004. The final sample has 1,056 bank-period observations.

Finally, we collect monthly data on the asset holdings of all fixed income investment funds in Brazil from September 2007 (1 year prior to the crisis) to December 2009 (the end of our study period) from Quantum Axis, which is a provider of data on investment funds in Brazil that extracts its information directly from Comissão de Valores Mobiliários (CVM, the Brazilian equivalent to the Securities and Exchange Commission—SEC).

Table II presents the summary statistics for the precrisis, crisis, and postcrisis periods. During the international turmoil in the second half of 2008, the other banks experience a negative change in both uninsured and total deposits, whereas the big banks experience a positive change. However, the other banks receive more deposits (both total and uninsured) than the big banks in 2009.

Throughout the sample period, the other banks pay higher mean interest rate margins on CDs than the big banks, but this difference spikes during the crisis and returns to slightly above precrisis levels in December 2009. The numbers are consistent with the idea that the big banks passively receive deposits during the crisis, while the other banks actively search for deposits.

Overall, both the big banks and the other banks notably increased their asset size and equity during the sample period. Because the big banks have larger branch networks than the other banks, they have a larger number of depositors and thus a smaller ratio of uninsured to total deposits. On average, the big banks have a slightly lower equity ratio and a higher ratio of low-quality loans to assets. At the beginning of the sample period, the big banks have slightly higher asset liquidity than the other banks, but during the periods immediately prior to the crisis, the turmoil, and after it, the other banks present higher asset liquidity than the big banks.

5. Results

Table III (Panels A and B) shows the regression results for uninsured and total deposits (columns 1 and 2) and for CDs held by different types of depositors (institutional investors, nonfinancial firms and individuals, respectively in columns 3, 4, and 5) using the GMM-Sys estimators.

Table III (Panel A) shows the baseline model (1) in which the set of big banks is defined according to the procedure described in Section 3.1. We find a positive and statistically significant ω for the uninsured deposit regressions (at the 1% level). These estimates are also economically large, corresponding

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Table II. Summary statistics

This table reports means and standard deviations (in brackets) of key variables for 2006–07, June and December 2008, and December 2009. The big banks and the other banks are defined in Table I (Panel A). Δtotal (uninsured) deposits is the first difference of the log of total (uninsured) deposits; ΔCDs held by (institutional investors, nonfinancial firms or individuals) is the first difference of the log of CDs held by each type of depositor; interest rate margin is the annualized interest rate paid on CDs issued by each bank minus the SELIC rate; equity ratio is the ratio of equity to total assets; low-quality loans is the ratio of low-quality loans to total assets; asset liquidity is the ratio of cash, tradable securities and net interbank to total assets; exposure to trade finance is the ratio of the amount of trade finance loans to total assets, and exposure to middle market is the ratio of the amount of loans to middle market firms to total assets; exposure to foreign funding is the ratio of foreign funds to total assets; Share of institutional investors is the ratio of the amount of CDs held by institutional investors to total assets; CDs of (institutional investors, nonfinancial firms or individuals)/Total CDs is the ratio of CDs held by each type of depositor to total CDs. FX Rate is the end-of period exchange rate in BRL/USD (average end-of-period for the 4 half-years in 2006–07).

	2006–07		Jun/2008		Dec/2008		Dec/2009	
	Big	Other	Big	Other	Big	Other	Big	Other
Total assets (BRL billions)	176.2	8.8	239.3	11.0	381.5	11.3	416.3	11.6
	[86.0]	[13.7]	[115.1]	[15.3]	[178.8]	[15.9]	[208.7]	[16.7]
No. of depositors (thousands)	14,159	215	15,507	246	21,548	236	23,939	139
	[9,484]	[697]	[11,109]	[771]	[11,395]	[793]	[12,094]	[337]
Uninsured deposits/total deposits (%)	62.6	87.6	63.7	88.1	65.5	88.2	62.8	78.9
	[13.5]	[16.2]	[14.7]	[16.3]	[12.7]	[15.7]	[12.3]	[20.1]
Δtotal deposits (%)	7.4	11.1	14.2	16.4	23.8	−10.7	2.4	13.0
	[8.5]	[28.3]	[8.6]	[28.7]	[15.5]	[34.9]	[6.3]	[28.8]
Δuninsured deposits (%)	3.4	9.5	20.4	17.7	30.5	−12.7	−0.7	12.4
	[17.4]	[31.0]	[11.5]	[30.2]	[22.9]	[35.3]	[9.9]	[30.2]
ΔCDs held by institutional investors (%)	−3.1	8.5	84.4	9.7	40.8	−26.0	−35.8	30.5
	[67.6]	[62.1]	[63.2]	[61.0]	[65.8]	[75.2]	[21.8]	[75.5]
ΔCDs held by nonfinancial firms (%)	2.5	11.4	38.6	28.6	38.1	−8.5	−6.3	9.1
	[17.9]	[35.7]	[19.8]	[31.9]	[34.9]	[32.4]	[19.0]	[27.1]
ΔCDs held by individuals (%)	9.9	10.0	40.5	22.3	41.4	7.6	−10.1	−4.6
	[17.7]	[22.3]	[17.4]	[26.3]	[23.7]	[27.6]	[4.0]	[16.5]
Interest rate margin (bps)	−37.44	3.41	−42.84	15.38	−76.96	63.71	−34.26	29.01
	[71.17]	[78.79]	[49.5]	[71.92]	[63.81]	[82.5]	[15.63]	[52.14]
Equity ratio (%)	9.1	13.8	8.3	14.4	8.3	14.1	9.8	14.8
	[2.6]	[7.2]	[2.1]	[7.1]	[3.6]	[7.0]	[5.5]	[7.0]
Low-quality loans (%)	2.6	1.9	2.3	1.5	2.4	2.0	3.2	2.2
	[0.5]	[2.1]	[0.3]	[1.8]	[0.2]	[1.9]	[0.5]	[1.7]
Asset liquidity (%)	23.3	32.0	19.9	26.9	20.8	27.6	19.8	27.7
	[11.5]	[18.4]	[10.2]	[15.7]	[10.3]	[14.2]	[8.1]	[17.5]
Exposure to trade finance (%)	8.0	7.3	7.0	7.6	7.9	8.7	5.3	9.1
	[4.7]	[9.7]	[4.0]	[10.0]	[4.8]	[10.4]	[3.1]	[10.2]

(continued)

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Table II. (Continued)

	2006–07		Jun/2008		Dec/2008		Dec/2009	
	Big	Other	Big	Other	Big	Other	Big	Other
Exposure to middle market (%)	24.2 [7.7]	29.2 [22.1]	25.2 [8.0]	32.8 [23.8]	27.0 [6.9]	35.5 [25.0]	29.2 [7.2]	38.4 [26.4]
Exposure to foreign funding (%)	4.2 [2.4]	8.9 [9.4]	4.1 [2.3]	8.7 [9.2]	4.0 [2.6]	12.8 [11.6]	2.5 [1.8]	8.4 [8.1]
Share of institutional investors (%)	2.4 [3.5]	5.8 [7.3]	3.3 [3.6]	6.3 [7.9]	2.6 [2.3]	3.7 [5.1]	1.6 [1.6]	3.7 [4.8]
Total CDs/Total deposits (%)	36.5 [19.8]	52.2 [24.5]	43.8 [23.7]	56.8 [23.1]	43.1 [19.6]	52.0 [23.2]	38.5 [16.5]	49.5 [24.2]
CDs of institutional investors/Total CDs (%)	12.6 [15.1]	26.5 [27.3]	14.8 [14.0]	26.3 [28.0]	12.1 [10.2]	20.7 [23.0]	9.0 [8.8]	20.1 [22.7]
CDs of nonfinancial firms CDs/Total CDs (%)	51.9 [10.2]	57.8 [28.2]	48.5 [8.0]	58.8 [28.8]	48.2 [7.6]	60.8 [26.1]	48.9 [11.3]	66.6 [27.7]
CDs of individual/Total CDs (%)	35.0 [11.8]	15.0 [12.8]	35.9 [9.2]	14.3 [13.2]	38.0 [5.8]	18.0 [15.6]	41.1 [6.0]	15.4 [13.8]
Observations	32	212	8	51	6	50	6	46
Exchange rate (BRL/USD)	2.00		1.59		2.34		1.74	

to a predicted increase of approximately 41 pp in uninsured deposits for the big banks relative to the other banks during the crisis. As expected, we find a positive but lower ω for the total deposit regressions, predicting an increase of approximately 33 pp in deposits for the big banks relative to the other banks during the crisis. The results for the institutional investors, shown in column 3 of Table III (Panel A), are even stronger. During the crisis, there is an expected increase of approximately 68 pp in the growth rate of CDs issued by big banks to institutional investors relative to those issued by other banks (significant at the 5% level).

The results in column 4 of Table III (Panel A) show that the expected increment for big banks relative to other banks in the growth rate of CDs held by nonfinancial firms during the crisis is approximately 43 pp (significant at the 1% level). The results for CDs held by individuals in column 5 show that ω is also positive, but not statistically significant at the usual levels. The data do not enable us to identify the CDs held by each type of depositor that are covered by deposit insurance, but it is reasonable to expect that a large portion of the CDs held by individuals are insured, making them less likely to run.

The coefficient of the big bank dummy variable is not statistically significant at conventional levels in any regression of Table III (Panel A).

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Table III. Change in deposits, financial crisis and systemically important banks

Panels A and B show the results of the estimation of Equation (1) using the (one-step) GMM-Sys estimator. Regressors: crisis is a dummy variable for the observation being during the international turmoil; size is the natural logarithm of the assets; big bank, big domestic, big foreign and powerhouse bank are dummy variables equal to one if the bank is clustered as such in Table I (Panels A and B); Δregional economic activity is the change in the retail sales index of the state in which the bank has more branches. Other variables are defined in Table II. Additional controls are the *i*-th bank's time invariant unobserved features; and time fixed effects. We allow regressors to be only sequentially exogenous, employing suitable lagged values as their instruments, except for the time dummies, Δregional economic activity, big bank, and the interactions with crisis, assumed to be strictly exogenous. Autocorrelation/heteroskedasticity-robust *t*-statistics are shown in parentheses. The estimates for the time dummies, the intercept, and the lagged dependent variables are omitted. $(t-1)$ indicates that the variable is in first lag. The variables that interact with crisis are lagged according to the variable that appears without interaction. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

Dependent variable	Δuninsured deposits	Δtotal deposits	ΔCDs held by		
			Institutional investors	Nonfinancial firms	Individuals
	(1)	(2)	(3)	(4)	(5)
Panel A—baseline specification: big banks					
Variables of interest					
Crisis	−0.271	−0.226	0.084	−0.111	0.333**
	(−1.569)	(−1.326)	(0.196)	(−0.602)	(2.110)
Big bank	0.001	−0.005	0.079	0.066	0.040
	(0.021)	(−0.177)	(1.501)	(1.601)	(0.867)
Big bank × crisis	0.410***	0.326***	0.682**	0.433***	0.128
	(3.263)	(2.944)	(2.083)	(2.993)	(1.033)
Control variables					
Size	−0.004	−0.005	−0.007	−0.022*	0.005
	(−0.414)	(−0.661)	(−0.494)	(−1.847)	(0.435)
Δinterest rate margin	3.521	4.414*	0.131	−2.152	−1.083
	(1.384)	(1.801)	(0.025)	(−0.635)	(−0.560)
Equity ratio $(t-1)$	0.264	0.210	0.970***	−0.098	0.024
	(1.445)	(1.222)	(3.508)	(−0.410)	(0.144)
Low-quality loans $(t-1)$	−0.208	−0.581	−1.224	−0.203	−0.161
	(−0.307)	(−0.920)	(−1.364)	(−0.347)	(−0.418)
Asset liquidity $(t-1)$	−0.006	−0.028	0.003	0.094	0.025
	(−0.081)	(−0.435)	(0.026)	(1.185)	(0.512)
ΔRegional economic activity	0.217	0.030	−0.508	0.340	−0.027
	(0.652)	(0.108)	(−0.733)	(1.146)	(−0.108)
Equity ratio × crisis	−0.823	−1.079	−2.072	−0.671	−1.163*
	(−1.182)	(−1.590)	(−1.336)	(−0.884)	(−1.670)

(continued)

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Table III. (Continued)

Dependent variable	Δuninsured deposits	Δtotal deposits	ΔCDs held by		
			Institutional investors	Nonfinancial firms	Individuals
	(1)	(2)	(3)	(4)	(5)
Low-quality loans × crisis	1.826	1.805	−4.197	0.632	−0.275
	(0.372)	(0.373)	(−0.520)	(0.257)	(−0.171)
Asset liquidity × crisis	0.402	0.407	−0.751	0.210	0.093
	(1.045)	(1.082)	(−0.806)	(0.573)	(0.527)
Time dummies	Yes	Yes	Yes	Yes	Yes
Lagged dependent variable	Yes	Yes	Yes	Yes	Yes
Observations	835	835	918	931	931
F	6.067	5.042	3.862	7.398	9.861
F (*p*-value)	<0.001	<0.001	<0.001	<0.001	<0.001
Hansen	49.99	50.69	50.50	48.59	48.63
Hansen (*p*-value)	>0.999	>0.999	>0.999	>0.999	>0.999
Panel B—alternative specification: big banks					
Variables of interest					
Crisis	−0.418**	−0.363**	−0.231	−0.171	0.181
	(−2.598)	(−2.228)	(−0.528)	(−0.940)	(1.359)
Big domestic bank	−0.032	−0.029	0.042	0.040	0.024
	(−1.091)	(−1.047)	(0.687)	(0.827)	(0.487)
Big foreign bank	0.020	0.010	0.078	0.068	0.054
	(0.647)	(0.369)	(1.353)	(1.363)	(1.110)
Global powerhouse bank	−0.056	−0.062*	−0.099**	−0.051	−0.033
	(−1.478)	(−1.677)	(−2.193)	(−1.419)	(−0.819)
Big domestic × crisis	0.507***	0.396***	0.955**	0.470**	0.264**
	(3.408)	(2.987)	(2.538)	(2.559)	(2.237)
Big foreign × crisis	0.336***	0.294***	0.273	0.423***	−0.016
	(3.964)	(3.441)	(1.374)	(4.629)	(−0.217)
Global powerhouse × crisis	0.407**	0.388**	0.819**	0.180	0.243*
	(2.572)	(2.427)	(2.347)	(1.382)	(1.840)
Control variables					
Size	−0.002	−0.003	−0.003	−0.019	0.005
	(−0.179)	(−0.358)	(−0.216)	(−1.541)	(0.428)
Δinterest rate margin	3.674	4.641*	0.514	−2.082	−0.926
	(1.438)	(1.861)	(0.096)	(−0.612)	(−0.484)
Equity ratio (t − 1)	0.290	0.230	1.020***	−0.068	0.010
	(1.565)	(1.330)	(3.908)	(−0.279)	(0.064)
Low-quality loans (t − 1)	−0.532	−0.826	−1.799*	−0.493	−0.340
	(−0.815)	(−1.419)	(−1.920)	(−0.840)	(−0.840)
Asset liquidity (t − 1)	−0.014	−0.029	−0.012	0.087	0.024
	(−0.199)	(−0.460)	(−0.089)	(1.085)	(0.496)
ΔRegional economic activity	0.112	−0.061	−0.694	0.266	0.132
	(0.338)	(−0.223)	(−1.022)	(0.890)	(0.670)
Equity ratio × crisis	−0.804	−1.053*	−2.038	−0.675	−0.912
	(−1.350)	(−1.775)	(−1.493)	(−0.911)	(−1.485)
Low-quality loans × crisis	4.621	4.385	1.598	1.800	0.584
	(0.972)	(0.937)	(0.203)	(0.817)	(0.286)
Asset liquidity × crisis	0.546	0.535	−0.407	0.267	0.069
	(1.603)	(1.592)	(−0.450)	(0.766)	(0.357)

(continued)

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Table III. (Continued)

Dependent variable	Δuninsured deposits	Δtotal deposits	ΔCDs held by		
			Institutional investors	Nonfinancial firms	Individuals
	(1)	(2)	(3)	(4)	(5)
Time dummies	Yes	Yes	Yes	Yes	Yes
Lagged dependent variable	Yes	Yes	Yes	Yes	Yes
Observations	835	835	918	931	931
F	20.31	19.25	6.34	58.40	21.41
F (p-value)	<0.001	<0.001	<0.001	<0.001	<0.001
Hansen	45.82	50.45	38.99	44.28	40.58
Hansen (p-value)	>0.999	>0.999	>0.999	>0.999	>0.999

This result suggests that the growth rate of deposits is similar for both the big banks and the other banks during normal times.

In the regression results shown in Table III (Panel B), we adopt the alternative definition of big bank (separating big domestic from big foreign banks and including a dummy for global powerhouse banks), as defined in Table I (Panel B). The estimates indicate that the domestic and the foreign big banks as well as the global powerhouse banks fared substantially better than the other banks, on average, during the crisis. The smaller point-estimates for foreign big, compared with domestic big and powerhouse banks, in the regressions for total deposits and uninsured deposits are consistent with the findings of Ongena and Penas (2009), suggesting that investors may perceive that bailouts would be easier (or more likely) when no coordination between regulators is needed. However, the differences between the estimated interaction coefficients in columns 1 and 2 are not statistically significant (based on Wald tests for the equality of coefficients). In the regressions by depositor type, shown in columns 3 through 5 of Table III (Panel B), we see that institutional investors and individuals favor big domestic and global powerhouse banks, while nonfinancial firms favor big domestic and big foreign banks during the crisis. Overall, our results suggest that both expected Brazilian government support and expected foreign government support influence depositor behavior during financial turmoil.

We also investigate whether depositors favor big government-owned banks compared with big private banks (the results of these regressions are in the Supplementary Appendix). We find that the estimates of ω are almost identical for big government-owned and big private banks in the uninsured and total deposit regressions.

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Table IV. Change in deposits, postfinancial crisis, and big banks

This table shows the results of estimations of Equation (1) using (one-step) GMM-Sys. The variable postcrisis is a dummy variable for the observation being during the periods after the international turmoil. The other variables are defined in Tables II and III. We allow regressors to be only sequentially exogenous, employing suitable lagged values as their instruments, except for the following regressors, which are assumed to be strictly exogenous: time dummies, Δregional economic activity, big bank, big bank × crisis and big bank × postcrisis. Autocorrelation/heteroskedasticity-robust *t*-statistics are shown in parentheses. The estimates for the intercept, control variables, and time dummies are omitted. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

Dependent variable	Δuninsured deposits	Δtotal deposits	ΔCDs held by		
			Institutional investors	Nonfinancial firms	Individuals
	(1)	(2)	(3)	(4)	(5)
Variables of interest					
Crisis	−0.303*	−0.223	0.104	−0.332*	−0.074
	(−1.852)	(−1.378)	(0.252)	(−1.730)	(−0.463)
Postcrisis	0.023	0.032	0.330	−0.252**	−0.143**
	(0.230)	(0.360)	(1.131)	(−2.009)	(−2.230)
Big bank	0.016	0.014	0.129**	0.102**	0.066
	(0.492)	(0.462)	(2.377)	(2.280)	(1.417)
Big bank × crisis	0.373***	0.276**	0.643*	0.429***	0.152
	(2.977)	(2.481)	(1.936)	(2.992)	(1.308)
Big bank × postcrisis	−0.096	−0.080	−0.431*	−0.167	−0.173***
	(−1.269)	(−1.370)	(−1.987)	(−1.515)	(−4.070)
Other control variables: Size, bank fundamentals (equity ratio, low-quality loans, asset liquidity), bank fundamentals × crisis dummy, Δinterest rate margin, Δregional economic activity, lagged dependent variable, time dummies.					
Observations	847	847	929	942	942
F	5.715	4.419	3.844	7.139	10.54
F (*p*-value)	<0.001	<0.001	<0.001	<0.001	<0.001
Hansen	45.78	45.15	35.18	41.70	37.31
Hansen (*p*-value)	>0.999	>0.999	>0.999	>0.999	>0.999
No. of banks	71	71	72	72	72

The estimates in Table III (Panels A and B) suggest that the positive spike in the deposits of the big banks during the financial crisis is better explained by the too-big-to-fail effect than by the heterogeneity in bank fundamentals or by a continuous size effect.

5.1 THE POSTCRISIS PERIOD

One potential concern with the causal interpretation of a positive and significant coefficient of the interaction crisis × big bank is that the big banks

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and the other banks may have different preexisting time trends in deposit growth. We are able to address this concern by investigating how the change in deposits evolved for the big banks and the other banks during the postcrisis period. To examine this change, we create the indicator postcrisis, which is equal to 1 for the period ending in December 2009 and 0 otherwise,[13] and add the interaction term big bank × postcrisis to our baseline specification.

The regression results in columns 1 through 5 of Table IV show that the coefficients for big bank × postcrisis are negative (although they are statistically significant only in the institutional investors and individuals regressions), while the estimates for big bank × crisis are only slightly affected. These estimates suggest a reversion of the run in the postcrisis period and reinforce the interpretation of a panic run during the crisis.

5.2 THE EFFECT OF INSTITUTIONAL INVESTORS ON OTHER TYPES OF DEPOSITOR

We previously showed that institutional investors promptly respond to the perception of a too-big-to-fail effect during the financial crisis. If depositors consider that banks that rely on institutional investors for funding may be threatened by large outflows during a crisis, they may run in anticipation of eventual market liquidity problems.

To assess whether the presence of institutional investors affects the decision to run, we follow Ben-David *et al.* (2012) and include in the model an interaction of the variable crisis with the variable share of institutional investors, defined as the ratio of the amount of CDs held by institutional investors to total assets. The results in columns 1 and 2 of Table V show that relying on institutional investors has a negative effect on deposit growth during the crisis (statistically significant at 1% for both uninsured and total deposits). Specifically, we find that if the proportion of assets funded by the CDs of institutional investors increases by 1 pp, the growth rate of both uninsured and total deposits is expected to decrease by approximately 3 pp during the crisis compared with normal times. Nonetheless, the estimates for the big bank × crisis interaction remain almost unaffected. These results could be driven by the fact that institutional investors are major runners, but we see that this is not the whole story when we analyze the results using different types of depositors.

The results presented in columns 3 and 4 of Table V show that the share of institutional investors is also negatively associated with the growth in CDs of both institutional investors and nonfinancial firms during the

[13] We choose to limit the post-crisis period to December 2009 because balance sheet data from June 2009 includes transactions made during the crisis.

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Table V. Share of institutional investors

This table shows the results of estimations of Equation (1) using (one-step) system GMM. The variables are defined in Tables II and III. We allow regressors to be only sequentially exogenous, employing suitable lagged values as their instruments, except for the following regressors, which are assumed to be strictly exogenous: time dummies, Δregional economic activity, big bank, and the interactions with crisis. Autocorrelation/ heteroskedasticity-robust *t*-statistics are shown in parentheses. $(t-1)$ indicates that the variable is in first lag. The variables that interact with crisis are lagged according to the variable that appears without interaction. The estimates for the intercept and some control variables are omitted. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

Dependent variable	Δuninsured deposits	Δtotal deposits	ΔCDs held by		
			Institutional investors	Nonfinancial firms	Individuals
	(1)	(2)	(3)	(4)	(5)
Crisis	−0.366**	−0.201*	−0.056	−0.162	0.255*
	(−2.538)	(−1.791)	(−0.153)	(−0.997)	(1.839)
Big bank	0.012	0.011	0.090	0.070*	0.045
	(0.379)	(0.392)	(1.557)	(1.683)	(0.994)
Big bank × crisis	0.356***	0.263**	0.552*	0.407***	0.156
	(3.341)	(2.570)	(1.938)	(2.819)	(1.309)
Control variables					
Share of institutional investors $(t-1)$	−0.270	−0.284*	−0.970**	0.109	0.036
	(−1.651)	(−1.789)	(−2.610)	(0.395)	(0.244)
Share of institutional investors × crisis	−3.200***	−2.937***	−5.672***	−1.940***	−0.279
	(−6.133)	(−5.641)	(−4.672)	(−3.595)	(−0.555)
Other control variables: Size, bank fundamentals (equity ratio, low-quality loans, asset liquidity), bank fundamentals × crisis dummy, Δinterest rate margin, Δregional economic activity, lagged dependent variable, time dummies.					
Observations	834	834	918	931	931
F	12.21	14.60	8.722	10.18	10.79
F (*p*-value)	<0.001	<0.001	<0.001	<0.001	<0.001
Hansen	49.85	49.18	45.30	47.32	40.04
Hansen (*p*-value)	>0.999	>0.999	>0.999	>0.999	>0.999
No. of banks	70	70	72	72	72

crisis. A 1 pp increase in the share of institutional investors is expected to decrease the growth in CDs held by nonfinancial firms (institutional investors) by approximately 1.9 pp (5.7 pp) during the crisis compared with normal times. Most importantly, our main inferences from the estimates of the big bank × crisis interaction remain robust when we control for the share of institutional investors.

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5.3 ROBUSTNESS CHECKS

We implement several robustness tests to verify the stability of our primary results. To address the concern that depositors respond to the transmission channels of the international turmoil to the Brazilian economy, we include as controls bank-specific risk factors that capture the decrease in economic activity and the tighter external financing conditions during the crisis.

To disentangle depositors' preference for the big banks due to either economies of scale or the ability to spread operating costs more efficiently from the too-big-to-fail effect, we include measures of branch diversification, portfolio diversification, and operating efficiency. We also investigate whether bank ratings are able to explain changes in deposits and check for non-random sample attrition (i.e., we determine the drivers of attrition in our sample and its implications for our inferences). The results (in the Supplementary Appendix) indicate that our inferences remain unchanged.

In addition, we perform other robustness tests that yield similar results and are available upon request: (i) check whether our inferences are robust to the inclusion of an indicator that the bank has publicly traded shares. The rationale for this test is that traded banks may be considered less opaque as a result of market scrutiny (e.g., analyst coverage) or better corporate governance; (ii) include the interaction of size with the crisis dummy, to check if our continuous measure of size affects depositors' decisions differently during the crisis; (iii) repeat all robustness tests reported above after adding the postcrisis dummy and its interactions with the robustness variables; and (iv) estimate Equation (1) controlling for changes in bank fundamentals to test if depositors are primarily sensitive to improvements or deteriorations in bank fundamentals rather than to their levels.

6. Additional Evidence on the Behavior of Institutional Investors: an Analysis at the Fund Level

In this section, we provide a further description of the run by institutional investors by analyzing asset allocation at the fund level. We also check whether fund features (size and foreign/domestic management) and dynamics (i.e., inflow/outflow of resources) are associated with the asset allocation between the CDs of big banks and other banks in normal times and during the crisis.

Investment funds in Brazil are required to adopt a classification based on the risk classes they assume. Fixed income funds are allowed to invest only in fixed income securities and basically hold treasury bonds and CDs (other securities correspond to less than 0.5% of their holdings). Our analysis

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focuses on fixed income funds, allowing us to concentrate on the changes in the holdings of CDs without any concern for whether managers switch between different asset classes during the crisis (e.g., selling equities and buying CDs). These funds held 437 billion BRL (230 billion USD) in assets as of September 30, 2007, representing 59.5% of the entire investment fund industry in Brazil.

All investment funds are required to disclose in detail their end-of-month asset holdings to CVM within 3 months. For example, assets held as of the end of January for a given year must be disclosed no later than the end of April of the same year.

6.1 DATA FROM INVESTMENT FUNDS

We exclude (i) funds of funds; (ii) funds for which total assets under management are less than 1 million BRL (approximately 500 thousand USD) on average; and (iii) funds with fewer than five subsequent monthly observations for the period. After all exclusions, our sample includes 927 fixed income funds and 14,037 fund-month observations. We are able to identify for each

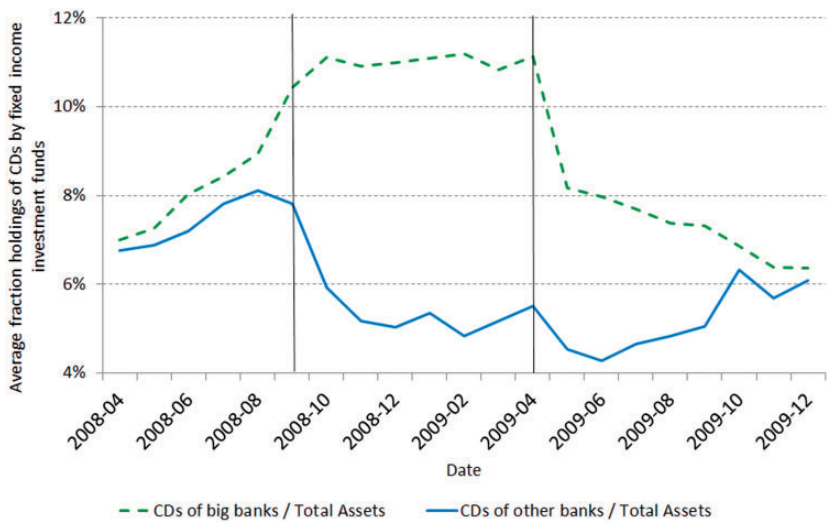

Figure 4. Average fraction holdings of CDs of big banks and other banks by fixed income investment funds. The solid and the dashed lines show respectively the monthly evolution of the average fraction holding of CDs of big banks and other banks by fixed income investment funds. "Fraction holding of CDs of big banks" of fund i in month t is defined as the ratio between the total value of CDs of big banks of the fund in month t and the total assets under management of the same fund in the same month. The fraction holdings of CDs of other banks are defined analogously. The two vertical lines show the beginning and end of the crisis period.

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observation (fund-month) (i) the management company; (ii) total assets under management; (iii) number and price of shares; and (iv) detailed asset holdings.

The assets held by these funds are manually identified and classified into four categories: (i) CDs of big banks; (ii) CDs of other banks; (iii) government bonds; and (iv) other securities. A little over half of the fixed income funds hold CDs in their portfolios, and approximately two-thirds of these hold CDs of both big and other banks. Detailed information on fund holdings is presented in the Supplementary Appendix.

We define the fraction holding of each asset category held by fund i in time t as the ratio between the total value of holdings of each asset category and the total assets under management. Figure 4 shows the monthly evolution of the average fraction holding of CDs of big banks and other banks. There is a sharp decrease in the holding of CDs of other banks starting in September 2008, along with an increase in the growth rate of the holding of CDs of big banks, stabilizing at approximately 11% throughout the crisis. There is a partial and gradual recovery in the fraction holding of CDs of other banks starting in June 2009, 2 months after the fraction holding of CDs of big banks starts decreasing.

6.2 ASSESSING THE RUN FROM OTHER BANKS TO BIG BANKS

We start by analyzing the subsample of 190 funds that hold both types of CDs as of August 2008, immediately before the crisis. These funds provide the ideal setting for observing a possible run from the other banks to the big banks during the crisis. We then check the robustness of our results for the entire sample of funds.

We estimate the following model to assess how the changes in the allocation of resources between big banks and other banks relate to fund characteristics and dynamics:

$$\begin{aligned}\text{Big Minus Other}_{i,t} &= \alpha + \zeta \text{Big Minus Other}_{i,t-1} + \beta \text{Crisis months}_t \\ &\quad + \gamma \text{Fund Size}_{i,t-1} + \delta \text{Net Flow}_{i,t-1} + \eta \text{Foreign Manager}_i \\ &\quad + \psi \text{Fund Size}_{i,t-1} \times \text{Crisis months}_t + \omega \text{Net Flow}_{i,t-1} \\ &\quad \times \text{Crisis months}_t + \nu \text{Foreign Manager}_{i,t} \times \text{Crisis months}_t + \mu_i + \varepsilon_i \end{aligned} \tag{2}$$

The dependent variable is the difference between the fraction holding of CDs of big banks and the fraction holding of CDs of other banks of fund i in month t.

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Crisis months is a dummy variable that assumes value 1 for the months from September 2008 to March 2009 and 0 otherwise. We define this period according to Aït-Sahalia *et al.* (2012). Fund size$_{i,t}$ is the natural logarithm of assets under management of fund i in month t. Foreign manager$_i$ is a dummy variable equal to 1 if the management company is a subsidiary of a foreign financial institution or asset management company and 0 otherwise. To account for fund dynamics, we compute the implicit net flow of resources of fund i in month t as follows:

$$\text{Net Flow}_{i,t} = \frac{\text{Assets}_{i,t} - \text{Assets}_{i,t-1} \times (1 + r_{i,t})}{\text{Assets}_{i,t-1}}, \tag{3}$$

where $r_{i,t}$ is the return of the share of fund i in month t.

The interactions of fund size, net flow, and foreign manager with the crisis dummy are included to check for differential effects from these variables on CD holdings during the crisis. Fund unobserved fixed effects are represented by μ_i, and ε is the error term.

We use the GMM-Sys estimator because net flow and fund size may be endogenously related to our dependent variable. For example, Schmidt *et al.* (2013) find that the net flow of resources for US money market funds during the crisis is related to asset holdings. In our case, shareholders may decide to buy or redeem their shares based on the exposure of the fund to a particular type of CD. Thus, we allow for feedback effects from our dependent variable to these two variables.

We check the robustness of our findings using the entire sample of fixed income funds. Because we are also interested in estimating the effects of the crisis on the allocation of assets into the CDs of big and other banks (and not just the difference between them), we run alternative specifications in which the dependent variables are the fraction holdings of CDs of each type. This allocation decision has a corner solution (allocation equal to zero) for roughly half of the observations. Therefore, the nature of the decision calls for the use of an estimation method suited to address the left-censored variable problem, such as Tobit.

Finally, we investigate the binary decisions on whether to hold CDs of each type, by running two Logit regressions in which the dependent variables are dummies indicating any holding of CDs of big banks and other banks respectively.

Column 1 of Table VI shows the regression results for our regressions on big minus other using the GMM-Sys. These results show that big minus other increases by approximately 8 pp on average during the crisis for the funds that held both types of CDs as of August 2008, meaning that fund

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Table VI. Determinants of asset allocation in CDs of big banks and other banks

Column 1 shows the results of the estimation of Equation (2) for the funds that hold CDs of both big and other banks in August 2008 using the (one-step) GMM-Sys estimator. The dependent variable is big minus other, the difference between the fraction holdings of CDs of big banks and other banks. Regressors: crisis months is a dummy variable for the observation being during the international turmoil (September 2008 to March 2009); fund size is the natural logarithm of the assets under management; foreign manager is a dummy variable equal to 1 if the fund management company is foreign; net flow is the net amount of inflows and outflows of the fund in a given month, computed according to Equation (3). We include the *i*-th fund's time invariant unobserved features, and allow the regressors to be only sequentially exogenous, employing suitable lagged values as their instruments, except for crisis months and foreign manager, which are assumed to be strictly exogenous. Estimations in columns 2 to 5 use the full sample of fixed income funds. Column 2 (4) shows the results of a pooled Logit regression, in which the dependent variable is a dummy for any holding of CDs of big banks (other banks). Column 3 (5) shows the results of a random effects Tobit regression, in which the dependent variable is the fraction holdings of CDs of big banks (other banks), and the independent variables are the same as in column 1, with the suppression of the lagged dependent variable. In all regressions, fund size and net flow are lagged. Autocorrelation/heteroskedasticity-robust *t*-statistics are shown in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

	Funds holding CDs of both types	All investment funds			
	Big minus other	CDs of big banks		CDs of other banks	
Dependent variable	(1) GMM-Sys	(2) Logit	(3) Tobit	(4) Logit	(5) Tobit
Lagged dependent variable	0.760***	7.709***	–	7.231***	–
	(38.36)	(63.35)	–	(66.06)	–
Crisis months	0.083*	2.137	0.096***	−1.050*	−0.164***
	(1.66)	(1.43)	(3.43)	(−1.68)	(−6.31)
Fund size	0.013***	0.166***	0.022***	0.104***	0.016***
	(3.99)	(3.70)	(10.09)	(2.99)	(7.22)
Fund size × crisis months	−0.005*	−0.103	−0.002	0.026	0.007***
	(1.83)	(−1.35)	(−1.42)	(0.33)	(5.42)
Net flow	−0.053***	1.560	−0.022	1.810	0.013
	(−2.71)	(1.20)	(−1.59)	(0.80)	(1.02)
Net flow × crisis months	0.030	−2.72	0.022	−1.788	−0.035
	(0.86)	(1.55)	(0.86)	(−1.09)	(−1.37)
Foreign manager	0.017	0.424***	0.048**	−0.206*	−.059***
	(1.22)	(10.10)	(2.73)	(−1.66)	(−3.78)
For. manager × crisis months	−0.038***	0.158*	−0.015***	0.368	−0.001
	(−3.42)	(1.84)	(−2.91)	(1.30)	(−0.10)
Constant	−0.255***	−7.074***	−0.625***	−5.568***	−0.486***
	(−4.02)	(−8.14)	(−14.61)	(−8.30)	(−11.63)
Observations	4,540	14,037	14,037	14,037	14,037
R^2/Pseudo-R^2	–	0.856	–	0.822	–
F/Wald	3002.7	4095.0	522.6	4573.1	205.1
F/Wald (*p*-value)	<0.001	<0.001	<0.001	<0.001	<0.001
No. of cross sections	190	927	927	927	927

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managers increase their allocation in the CDs of the big banks during the crisis and reduce their allocation in the CDs of small and medium banks.

Columns 2 through 5 of Table VI show the results of the pooled Logit and Random Effects Tobit regressions for the entire sample of funds. Overall, our estimations suggest that the crisis has a negative and significant impact on both the binary decision to hold CDs of other banks (column 4) and the fraction holding of CDs of other banks (column 5), whereas it has a positive and significant impact on the fraction holding of CDs of big banks (column 3).

Other results show that fund size is positively related to the probability of holding CDs of both big and other banks (columns 2 and 4) as well as to the fraction holdings of CDs of both types (columns 3 and 5). This finding is consistent with the idea that larger funds are more diversified, thereby holding assets other than treasury bonds in their portfolios. Fund size is also positively associated with big minus other. One possible explanation for this finding is related to transaction costs: for a given desired allocation between CDs and treasuries, larger funds demand a greater dollar amount of CDs, and it may be less costly for managers to invest in a single (or a few) large banks instead of many small banks.

The estimates for the coefficient of fund size × crisis in columns 1 and 5 of Table VI indicate that the negative impact of the crisis on the fraction holdings of CDs of other banks is smaller for larger funds, possibly because larger funds are more diversified and can thus withstand temporary losses for these CDs.

As shown in the GMM regressions, net flow is negatively related to big minus other, which suggests that managers buy/sell CDs of other banks to meet incoming flows and redemptions. The signs of the coefficients of the Tobit regressions are consistent with this interpretation although not statistically significant. The relationship between asset allocation and net flow is not particularly affected by the crisis.

The results in columns 2 through 5 show that, in normal times, funds managed by a foreign company have an increased propensity to hold CDs of big banks and a lower propensity to hold CDs of other banks in comparison to funds managed by a domestic company. However, when the sample is restricted to funds that hold both types of CDs (column 1), the coefficient for foreign manager is not significant, indicating that the asset allocation in CDs conditional on holding CDs of both types is not significantly different between foreign and domestic management companies. The results in column 1 show that, during the crisis, funds managed by foreign companies do not increase big minus other as much as their domestic counterparts. In fact, the result in column 3 shows that foreign managers increase

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the fraction holdings of CDs of big banks less than their domestic counterparts during the crisis, but their probability of holding some amount of CDs of big banks (column 2) is increased relative to domestically managed funds.

We run several robustness checks that are described in the Supplementary Appendix. Our inferences remain unchanged.

7. Concluding Remarks

This article investigates whether depositor behavior is affected by the perception of a too-big-to-fail policy. The focus on Brazil during the crisis of 2008 allows us to mitigate the endogeneity concerns present in cross-country comparisons while taking advantage of a detailed proprietary database and of market and institutional features useful for the identification of a too-big-to-fail effect.

Our results indicate that the depositors value an implicit governmental guarantee to the systemically important banks over and above economic fundamentals. Additionally, the banks that rely more on institutional investors for funding suffer more deposit outflows, not only from institutional investors themselves but also from nonfinancial firms.

Our findings suggest that systemically important banks have a competitive advantage in the form of extra access to funding liquidity from depositors in times of financial turmoil. Given similar circumstances, it is plausible that depositors will put their money into systemically important banks during the next crisis, and this behavior may be more significant in Europe and the USA, where most of the bailouts occurred. A related avenue for future research is to assess whether the resulting concentration of deposits at the systemically important banks leads to credit rationing for the borrowers of the smaller banks or if the systemically important banks replace the smaller banks and lend to those borrowers.

Academics and policy makers still debate the effectiveness of the recent regulatory changes aimed at ending the too-big-to-fail problem. One implication of our study is that the advantage of extra liquidity in the deposit markets should be considered when balancing the costs and benefits of these changes together with the issues of increased moral hazard and lower cost of capital documented in the literature. For example, increasing the capital and asset liquidity requirements of systemically important institutions aims to lower their default probabilities and narrow the gap between the cost of capital of systemically important banks and that of other banks. The downside of labeling banks as systemically important is that the label may further increase depositors' expectation of government support. Ring

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fencing banks' activities aims at lowering default probabilities and simplifying the resolution process. Requiring systemically important institutions to develop their own resolution plans (living wills) also aims to simplify the resolution process. These regulatory changes could provide credibility to a no-bailout commitment and affect the banks' cost of capital, moral hazard, and depositor behavior, but they are harmed by the absence of a supranational resolution framework that ensures timely regulatory intervention and disposition without causing major disruptions to the overall economy.

To level the playing field in the deposit markets, governments could increase deposit insurance or limit the size of banks. In the first alternative, depositors would feel equally safe in any bank, so long as the insurance scheme is credible. The downside of a generous deposit guarantee is increased moral hazard and sovereign debt concerns. The size limit could be such that no bank is considered to be systemically important anymore. The problem with this approach is that size limits may hinder economies of scale and scope, risk diversification, and the functionality of the global capital markets. In addition, these limits may create a too-many-to-fail problem if several banks, however small, become distressed at the same time (Acharya and Yorulmazer, 2007).

Given its many facets, we suspect that the too-big-to-fail problem will remain an active topic of research in the future.

Supplementary Material

Supplementary data and additional analyses are available at *Review of finance* online.

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