The Global Impulse in Commercial Banking and its Implication for Bank Behavior during the Financial Crisis

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This version: 2 June 2016

Abstract:

Banks with positive net foreign assets (global banks) are some of the largest and most ubiquitous commercial banks in the United States, and they have developed sophisticated financial flows within their branches and subsidiaries . Using data from the Call Reports of the Federal Reserve System about US-based banks, we investigate (1) the determinants of the bank decision to "go global" and (2) the balance-sheet choices made by banks in the 2002q1 – 2010q4 period. We are especially interested to learn whether global banks make different choices in structuring their balance sheets, and whether such differences persisted into the period of the financial crisis.

We uncover the strong positive correlation of global bank status and size (as measured by total assets). We then create a size-free measure of global status that we call the "global impulse". We then use this in our investigation of balance-sheet choices.

We use two technical tools to investigate this: a matching exercise of global and non-global banks, and a difference-in-difference analysis that measured the impact of global impulse on bank choices during pre-crisis and crisis periods. We find, for example, that global banks did reduce interbank borrowing and lending significantly relative to non-global banks during the crisis, but that this relative reduction reversed the significantly greater reliance these banks had had on those channels in the pre-crisis period.

Banks with positive net foreign assets are some of the largest and most ubiquitous commercial banks in the United States, and they have developed sophisticated financial flows within their branches and subsidiaries (Cetorelli and Goldberg (2013)). They are among the most profitable of banks, but during the recent financial crisis they were identified as vehicles of international shock transmission (Acharya and Schnabl (2010) and Shin (2011)). The interbank market served as one channel for shock transmission – this was borrowing and lending between independent banks, and was subject in the crisis to concerns about counterparty risk (Heider et al., (2010)). A separate channel identified by Cetorelli and Goldberg (2012) exists through within-bank lending and borrowing: that is, credit flows within these banks. We will refer to these banks as global banks, or equivalently as banks with global status.

As von Peter and McGuire (2009) point out, commercial banks throughout the world expanded their assets through purchase of USD-denominated claims on non-bank entities. These were typically USD-denominated debt instruments (collateralized debt obligations, corporate bonds) and were financed through the issuance of own liabilities (for example, on interbank markets). These assets lost value as the US crisis intensified, causing commercial banks in advanced countries to reduce their liabilities in synchronized fashion. Kamin and De Marco (2010) called this propagation channel "direct contagion", and found that it was a relatively minor transmission channel.

The expansion of bank balance sheets throughout the world was disproportionately financed through issuance of USD-denominated short-term liabilities. When the crisis began, all commercial banks had difficulty in "rolling over" these liabilities. When rolling over was not possible, the banks had to sell assets at fire-sale prices in order to retire the liabilities. Raddatz (2010) demonstrated that for banks in 44 countries, those with large non-deposit liabilities experienced a significantly larger fall in equity value in the aftermath of the AIG nationalization.

Kamin and De Marco (2010) attribute the majority of the propagation effect across borders to what they call "indirect contagion". In their view, financial actors throughout the advanced economies observed the US experience. They also observed that banks in other countries and had adopted a similar, highly leveraged, business model. This observation triggered a synchronized "run" on the banks in advanced economies. Blanchard (2008) also notes the importance of "bank run" mentality in the amplification of the crisis and its spread across borders.

We've learned from the researchers cited above that global banks responded significantly differently from non-global banks to the financial crisis beginning in 2007/2008. These significant differences were in their equity positions, in their interbank borrowing and lending, and in their reliance on within-bank borrowing and lending.

These are important findings. We know, though, that banks' management of assets and liabilities has been shown in the literature to respond to factors other than global status. The size of the bank (Gropp and Heider (2010)), the risk preference (Chmielewski (2005)), the demands of regulators (Rosen (2003)) – all factor into balance-sheet management.[1] At the same time, we

[1] Adrian and Shin (2011) provides a nice summary of this.

know that global banks tend to be larger banks as well. There is a robust relationship between bank size and the percentage of banks of that size that are global. Could the findings in this literature be an artifact of the behavior of large firms rather than of global firms?

We report three empirical results in this paper. First, the selection of global status based on size is an important and robust feature of commercial banking in the United States. We describe this robust linkage using the Call Reports of the Federal Reserve System. Second, we introduce a new way of separating the effect of global status from the effect of size when considering balance-sheet management. We define what we call the "global impulse". If we compare two banks of equal size (defined in terms of total assets at a given point in time), the one with global impulse is more likely to have global status. Third, we demonstrate that large and significant differences in banking decisions emerged in the profitable run-up to the Great Recession when we compare banks with and without the "global impulse". The financial crisis was characterized by significantly larger shifts in balance-sheet positions by banks with the global impulse, but these shifts in fact were due to those banks unwinding their riskier portfolio position taken in the run-up to the financial crisis. The net effect of global-impulse banking decisions in the financial crisis was to bring the global banks closer in their choices to the decisions made throughout the decade by the non-global banks. We test this hypothesis by setting up a modified difference-in-difference estimation structure.

1. Characterizing the US Banking Sector and Descriptive Statistics of Global and Non-global Banks

We examine the behavior of US commercial banks from the first quarter of 2001 (2001q1) to the fourth quarter of 2010 (2010q4) using the Call Reports of the Federal Reserve System. We measure the balance-sheet management of a commercial bank by calculating various measures of assets, liabilities and net worth as percentages of the total assets of the bank. The commercial bank is the unit of analysis, although we will allow for commercial banks as constituent members of larger holding companies. If a commercial bank is observed in every quarter, we have 40 quarterly observations for that bank. We examine the behavior of US-resident commercial banks. There are 4,151 banks in the sample.[2]

We have nine indicators of banking balance-sheet management at the level of the individual bank. The first six are defined as percentages of total assets: equity to total assets (E_{it}), liquid-asset holdings to total assets (LA_{it}), interbank borrowing to total assets (IB_{it}), interbank lending to total assets (IL_{it}), within bank borrowing to total assets (WB_{it}) and within-bank lending (WL_{it}) to total assets. We also consider leverage (L_{it}) as the ratio of total liabilities to total equity, non-performing-loans as a share of total loans (N_{it}), and the ratio of total deposits to total liabilities (D_{it}).[3] Our hypothesis is that the commercial-bank choice of these variables is a function of bank

[2] We begin with balance-sheet ratios for 4,924 commercial banks over this period. Given our interest in the global impulse, we filter the data by excluding observations from banks with smaller size than the smallest global bank. Data preparation is explained in detail in the Appendix.

[3] Comparing these variables to the bank's balance sheet, we see that the liabilities side of the balance sheet is completely represented, with L_{it} and E_{it} including all liabilities and all net worth, respectively. Among the bank's liabilities are WB_{it}, IB_{it} and D_{it}. On the assets side of the balance sheet, there are two major missing elements:

size, bank regulation and market volatility. In addition, we hypothesize that these choices depend upon the bank's "global impulse" – its desire to have global status. We define global impulse formally in the next section.

Our hypothesis states that balance-sheet management will differ across banks by global impulse. It also states that the effect of the global impulse on balance-sheet management will be different in crisis periods when compared to periods of calm. We will define the period of calm as 2002q1 up to 2007q4. The crisis period is then 2008q1 to 2010q4. This set of dichotomies -- global impulse vs. no global impulse, and period of calm vs. period of crisis – can be examined formally through a difference-in-difference statistical testing structure.

Following Cetorelli and Goldberg (2012a), we define a global bank (or, equivalently, a bank with global status) as one with positive foreign assets on its balance sheet. The global impulse is the desire to manage a global bank. While it would seem to be a choice that the bank management can revisit at any time, it was exceedingly rare for commercial banks to change their status (from non-global to global, or vice versa) during the 2002-2010 period.[4] We thus treat the global impulse as a characteristic of bank management set prior to the period under consideration.

We have seven variables that we treat as exogenous. We introduce binary variables indicating the regulatory agency for the bank: $O_i = 1$ if regulated by the Office of Comptroller of Currency (OCC) and zero otherwise; $F_i = 1$ if regulated by the Federal Reserve and 0 otherwise[5]. A bank as a member of a holding company is indicated by $H_i = 1$ if a holding-company member and 0 otherwise. If the bank is the largest constituent in the holding company, we define a binary variable $HH_i = 1$ (and 0 otherwise). We measure size by the logarithm of total assets. If TA_{it} is the constant-dollar value of total assets of bank i in time t, then size (s_{it}) is $s_{it} = \ln(TA_{it})$. We include a variable A_{it} to control for the age of the bank. We consider the interest-rate spread between the 10-year US Treasury bill and the Federal Funds rate as a measure of financial-market volatility. We denote this rate SPR_t.

Table 1 shows basic statistics for global and non-global banks respectively for the pre-crisis period of 2002q1-2007q4. Nearly half of global banks are regulated by the FDIC, while this share is slightly higher for non-global banks. The OCC has the second highest share in global bank regulation and the OCC's share is slightly lower for non-global banks. Thirty-five percent of global banks are affiliated with a bank holding company, with only 14 percent of non-global banks with such affiliation. Fourteen percent of global banks have a leader position in a holding company, while only six percent of non-global banks do so. Global banks are larger on average. Global banks hold a larger equity share on average than large non-global banks. They tend to hold a smaller share of liquid assets in total assets and have higher non-performing loans. Global banks rely on deposits less than non-global banks in financing their activities and they are also

performing loans and real assets (building, equipment, and other). Representing the asset-management positions are IL_{it}, WL_{it} and LA_{it}.

[4] During this period, of the 4151 banks in the sample, only 20 banks changed their status once or more.

proportionately more active in the interbank market; that is, they are borrowing and lending more than non-global banks.

Table 2 shows basic statistics for the crisis period 2008-2010. The FDIC regulates still nearly half of global banks and the OCC still has the second highest share in the global bank regulation. The FDIC regulates higher and the OCC regulates lower share of non-global banks than global banks. Once again, bank holding company affiliation and leader position are more common among global banks. These shares are 37 and 16 percent respectively for global banks. Global banks are larger and they have higher equity share. While liquid asset holdings of global banks are slightly lower than non-global banks, nonperforming loans of global banks are slightly higher. Global banks borrow and lend more than non-global banks in the interbank market.

When we compare banks in the calm period (Table 1) to banks in the crisis period (Table 2), we find that the share of the OCC is slightly higher and the share of the Fed is lower in the crisis period for global banks while the opposite is true for the non-global banks. The size of both global and non-global banks are slightly larger in the crisis period. The share of equity and the share of liquid assets declined slightly for both global and non-global banks in the crisis period. Unsurprisingly, nonperforming loans share increased in the crisis period and interbank activities of both group of banks declined. While the within-bank borrowing of global banks increased, within-bank lending declined in the crisis period.

These descriptive statistics demonstrate two empirical regularities of importance to this study. First, global banks are on average larger and differently regulated than non-global banks. They also seem to structure their balance sheets differently. Second, bank behavior during the crisis period was markedly different from that during the calmer run-up to the financial crisis. In the following sections we control for the impact of size on global status by deriving the global impulse. We then examine whether that global impulse is in fact responsible for the differences in balance-sheet choices. By doing so, we separate the impact of size from the impact of going global.

2. The Global Impulse.

In this section we first demonstrate that there is a positive and robust correlation between bank size and global status. We then create the "global impulse" for each bank as the difference between the bank's actual global status and its predicted status based upon its size.

We illustrate the link between bank size, number of banks and global status in Figure 1. On the horizontal axis we indicate the size of the bank in logarithms, and on the vertical axis we indicate the number of banks in the sample in 2001q1. The black line illustrates the non-global banks, beginning from a minimum size of 9.13 and rising rapidly in number as size rises. The red line illustrates the global banks: it begins at a higher size and rises less rapidly in number as size rises. The left vertical axis measures the non-global banks, while the right vertical axis measures the global banks. Global banks are thus smaller in total number than non-global banks, but are more likely to be observed at larger size.

We can see clearly that non-global banks begin from a smaller size in this sample, and that for a range of smaller sizes only non-global banks are observed. Given our concern with the confounding effects of size, we design our analysis to exclude these banks of very small size; we will focus only upon those for which both global and non-global banks are observed at the same size.

Figure 2 illustrates this by providing a non-parametric estimate of the likelihood that a bank of a given size is a global bank. The figure depicts the kernel-weighted local polynomial regression of global status on s_{it} in US-resident commercial banks in time 2001q1. We call this empirical relationship $\varphi(s_{it})$.

We define G_{it} as a binary indicator of global status of bank i in time t. We posit that

$$G_{it} = \begin{cases} 1 & \text{if } g_{it} > 0 \\ 0 & \text{if } g_{it} \leq 0 \end{cases} \quad (1)$$

We define g_{it} as an unobserved variable with two components:

$$g_{it} = \varphi(s_{it}) + GI_{it} \quad (2)$$

$\varphi(s_{it})$ represents the non-linear dependence of the choice of global status in period t on the size of the bank in that period. As a bank grows larger its clients' activities spread across borders and daily banking behavior leads to holding of foreign assets. GI_{it} is the global impulse of bank i in period t. As is evident from (2), the bank can hold positive foreign assets either because it is large, or because it has a positive global impulse.

Figure 2 illustrates that $\varphi(s_{it})$ is equal to, or approximately equal to, zero for s_{it} less than 12.02. Our interest is in the impact of global impulse on commercial bank behavior, and this will be impossible to identify for banks smaller than this cutoff size. We will then in what follows limit our attention to the 24 percent of banks in this sample that are larger than 12.02. **(This subset of banks holds xx percent of the total assets of commercial banks reporting in this period.)** Figure 3 illustrates $\varphi(s_{it})$ for the banks with $s_{it} > 12.02$.

Figures 1, 2 and the $\varphi(s_{it})$ in Figure 3 are created non-parametrically. In the sections that follow, we will use a parametric approximation $f(s_{it})$ to this likelihood of global status that is created with a probit regression of G_{it} on a third-order polynomial in s_{it}. The coefficient estimates of $f(s_{it})$ for the sample of banks with $s_{it} > 12.02$ in 2001q1 are given in Table 3. Figure 3 illustrates $f(s_{it})$ for that sample and the similarity to the non-parametric representation of $\varphi(s_{it})$. We also estimate $f(s_{it})$ for the entire sample 2002q1 to 2007q4, and report those coefficients in Table 3. We illustrate its values for the same range of sizes in Figure 3 as well.

Once we exclude the impact of size, a given bank's "global impulse" (or motivation to go global) could come from any of these three reasons:

- Bank managers might want to take advantage of profit opportunities that foreign country offers. The existence of high return projects in other countries make having an affiliate in a foreign country attractive.
- Bank managers might want to benefit from funding opportunities that foreign country offers. For instance, a country offering a good deposit base might be attractive location for this reason. These two motives are actually similar to Cetorelli and Goldberg (2012b)'s "core investment" and "core funding" affiliate definitions respectively.
- Bank managers may find it attractive to establish an internal capital market with a foreign subsidiary with the purpose of mitigating the effects of local shocks. This motivation is in line with Kalemli-Ozcan, Papaioannou, and Perri (2012)'s findings that multinational banks mitigate parent banks' local shocks.

The variable GI_{it} in (2) models this otherwise-unobserved characteristic of the bank: an impulse to take on global status even when it is not indicated by the size of the bank. This impulse may stem from the philosophy of the bank's managers or from the special aptitudes of the bank employees, but ends in the choice to "go global". The inequalities in (1) do not allow us to identify the absolute value of GI_{it} empirically, and so we use the estimate

$$GI_{it} = G_{it} - f(s_{it}) \qquad (3)$$

Where $f(s_{it})$ is the propensity-score estimator of the unobserved $\varphi(s_{it})$. To illustrate, suppose that banks j and k both have a propensity score $f(s_{jt}) = f(s_{kt}) = 0.5$ in time t because of their equal size. If bank j has global status and bank k does not, then

$$GI_{jt} = G_{jt} - f(s_{jt}) = 1 - 0.5 = 0.5$$

$$GI_{kt} = G_{kt} - f(s_{kt}) = 0 - 0.5 = -0.5$$

We observe a positive global impulse for bank j in time t, and a negative global impulse of bank k in time t.[6] In the next section, we'll discuss the results from propensity-score estimation.

[6] The difference in signs will always be the case, given the construction of GI_{it}. It will also always be the case that the quantitative value of GI_{it} for two banks of equal $f(s_{it})$ will differ either by 0 or 1. The larger is s_{it}, the smaller will be the positive global impulse for a bank of global status, and the larger the negative global impulse for a bank with non-global status.

3. Empirical Results for the Pre-crisis period

Table 1 discussed in the previous section illustrates that global banks in our sample have on average significantly larger size than non-global banks. This finding is in line with the literature including Correa, Goldberg and Rice (2014), Liu and Pogach (2014) and others which has shown that global banks tend to be larger in size than non-global banks. In this section, we will first analyze the role of bank size in banks' decisions to become global banks. Following that, we will analyze banks' balance sheet management after controlling for the confounding effect of bank size on bank decisions for the pre-crisis period and post crisis periods.

3. 1. Matching Estimation for 2002-2007 period

We will use propensity-score matching to eliminate the confounding effects of size in estimating the impact of global impulse on bank balance-sheet shares for the period 2001-2007. The propensity score is the value of the function $f(s_{it})$ where $f(s_{it})$ in this case is a third-order polynomial estimate in Table 3.

We match banks with "closest neighbor" propensity scores, and then test the difference in means of balance-sheet shares between banks with positive and negative GI_{it}. Table 4 shows the average treatment effect (ATE hereafter) on the bank's choice of balance-sheet shares of shifting from negative to positive global impulse for banks with $s_{it}>12.02$ and for period 2002q1 to 2007q4. We find in Table 4 that banks of global impulse are different from those without global impulse in their shares of equity holdings, their non-performing loans, and their lending on interbank markets. Since the global impulse is a choice made by a bank to become global that is distinct from the tendency to assume global status as the bank grows larger, these estimated ATE show that this global impulse choice is correlated with significantly different choices on shares of balance-sheet items.

The equity share result indicates that banks with global impulse during this pre-crisis period held on average 3.25 percentage points more of total assets in equity than the banks without global impulse. This speaks to a more cautious liability-management strategy that is also evident in the negative leverage statistic in Table 4. The increased equity shares may in part be a response to the significantly greater share of non-performing loans in banks with global impulse: in this pre-crisis period, non-performing loans of banks with global impulse were 0.97 percentage points more of total loans. The largest quantitative difference is in interbank lending (IL_{it}); banks with global impulse allocated 8.09 percentage points more of total assets to interbank lending than the banks without global impulse.

In section 3.2 we deepen this analysis and control for other bank characteristics as well.

3. 2. Global-impulse Estimations for the 2002-2007 period

Our propensity-score estimation based on (1) and (2) provides us with an estimate GI_{it} of each bank's global impulse as defined in (3). The propensity-score probit at the basis of this is reported in Table 3. We recognize, though, that bank choices of balance-sheet shares will not depend only on this global impulse. In this section, we introduce a number of exogenous variables to control for bank characteristics that are known to influence bank decisions: size (s_{it}), affiliation with a

bank holding company (H_i), leading bank for a holding company (HH_i), and regulation by the Office of Comptroller of Currency (O_i) or the Federal Reserve (F_i). (The FDIC is the omitted regulator.)

Alternative explanations of bank balance-sheet allocations have focused upon the evolution of global risk during this period. As a proxy for this risk we consider the interest-rate spread between the 10-year US Treasury bill and the Federal Funds rate. We denote this rate SPR_t. Our regression is

$$Y_{it} = a_o + b(s_{it}, A_{it}, O_i, F_i, H_i, HH_i, SPR_t) + a_1 GI_{it} + e_{it} \quad (4)$$

With Y_{it} one of the nine bank balance-sheet choice variables, b(.) a non-linear function of its exogenous arguments, and a_1 the coefficient of the global impulse. The coefficient a_1 measures the average difference in balance-sheet allocation between global and non-global banks after controlling for the effect of size and other exogenous controls. The function b(.) is modeled for simplicity as a third-order polynomial in s_{it} and a linear function of A_{it}, O_i, F_i, H_i, HH_i and SPR_i.

Use of this regression structure provides a more nuanced picture of the role of global impulse than the matching exercise. In matching we did not introduce the other exogenous determinants, while in this regression analysis we can. Using the global-impulse variable GI_{it} also in effect provides a weighting of observations different from the equally-weighted observations in matches and the zero-weighted observations not in matches. GI_{it} will be largest in absolute value for small global banks and large non-global banks; given the effect of size on global status, we expect these observations to be more informative of the impact of global impulse on bank balance-sheet shares.

Table 5 shows that these bank characteristics such as regulatory agency, holding-company affiliation, and size all have statistically significant effects on bank balance-sheet allocations.[7] The financial-risk variable SPR_t is also found to be significantly linked to increased nonperforming loans and to reduced deposit shares in total liabilities.

The results of our matching exercise for global impulse (GI_{it}) are confirmed in these regressions. The share of equity is significantly higher for those banks with global impulse, and the bank's leverage position is correspondingly less. The banks of global impulse hold significantly larger shares of non-performing loans. In addition, these regressions identify that banks with global impulse hold significantly greater shares of deposits in total liabilities and significantly smaller shares of liquid assets. These were insignificant effects in the matching exercise.

Table 6 reports the determinants of bank shares of total assets in interbank borrowing and lending. In the matching exercise we found a significant and quantitatively larger share of interbank lending for banks of global impulse, and an insignificant and slightly larger share of interbank borrowing. The quantitative effects remain with this regression analysis, but they are now statistically

[7] We use the criterion of a 95 percent level of confidence as our standard of statistical significance.

significant: banks with increased global impulse both borrow and lend more in the interbank market than non-global banks, with the quantitative effect on interbank lending being larger.

Our findings in this section are consistent with our priors about banks with the global impulse. The fact that we do not have access to global banks' foreign country data limits our chances of analyzing the first motive. However, our results indicating that the share of (consolidated) deposits to total liabilities are higher for greater global impulse might mean that the global banks in our sample took advantage of better funding (deposit) opportunities in a foreign country. Banks with greater global impulse are shown to also have higher interbank borrowing and lending, suggesting that at that time they were not using within-bank transactions as a substitute for the interbank market. The combination of positive within-bank transactions, larger interbank transactions and significantly smaller holdings of liquid assets indicate that in the pre-crisis period these banks of global impulse were more strongly reliant upon intra- and inter-bank transactions for liquidity needs. We emphasize that these are results independent of their choices due to larger size – it is the impact of global impulse.

4. Empirical Results – including the Crisis Period.

The potentially different behavior of global banks became a question of interest during the financial crisis of 2008-2010. Cetorelli and Goldberg (2012b) predicted that these global banks would need to adjust their balance sheets less to the crisis because of the availability of foreign assets (and foreign partners). Similarly, De Haas and Lelyveld (2014) showed that parent banks that lost access to wholesale markets repatriated funds from subsidiaries to headquarters during the recent crisis. Therefore, these global banks adjusted less in their home country when compared with nonglobal banks in their home countries. Duwel (2013) analyzed how exposure of German parent banks to securitized loan market affected their global fund management and to what extent vulnerability of parent banks to drying-up of repo markets reduced their support for affiliated banks. The results showed that parent banks which were more exposed to the disruptions in the repo market were more likely to withdraw internal funds from their branches and subsidiaries located abroad.

Based on the preceding section, though, we can see that the converse could also hold – the global bank is exposed to global shocks in addition to negative domestic shocks to asset values. The net impact of these two effects will be calculated empirically in both matching exercise and a difference-in-difference structure.

When we look at the relation between bank size and global status in 2008q1, we find that being global is still associated with bank size. Kernel-weighted polynomial regressions in 2008q1 (not reported, but available on demand) generate $\varphi(s_{it})$ almost identical to those for 2001q1 illustrated in Figure 2. To calculate GI_{it} for this period we re-estimate the probit $f(s_{it})$ for 2002q1-2010q4; the results of that probit are reported in the last columns of Table 3.

4.1. ATE calculations

We undertake a matching exercise similar to that of Table 4 for the 2008-2010 period. Table 7 shows the average treatment effects for the crisis period for banks with global impulse relative to banks without (or with negative impulse).

Banks with global impulse in this period hold larger equity shares as a percent of total assets than their non-global comparators – the point estimate of the percentage-point difference in equity shares is larger in the crisis period than the non-crisis period. (The implied difference in leverage is also larger and statistically significant, unlike in the pre-crisis period.) The difference in share of non-performing loans to total loans is quantitatively small and statistically insignificant when global and non-global banks are compared; this is a relative improvement for banks of global impulse. The difference in share of interbank lending remains quantitatively large and positive in the crisis period, but in this period the effect is statistically insignificant.

We also observe two statistically significant differences that were not apparent in the pre-crisis period. During this crisis period, banks of global impulse had significantly smaller shares of liquid assets to total assets and significantly smaller shares of interbank borrowing to total assets. The banks with global impulse are at the same time relatively less reliant on liquid assets and relatively less reliant on interbank borrowing. This suggests that these banks of global impulse are reliant on within-bank borrowing, but confirmation will require the estimation structure of the next section.

4.2 Difference-in-Difference estimations over the 2001-2010 period

In order to analyze the adjustment that global-impulse banks went through in the crisis period, we will estimate the difference-in-difference specification in equation (5). Our regression is

$$Y_{it} = d_o + c(s_{it}\ ,\ A_{it}\ ,\ O_i,\ F_i,\ H_i,\ HH_i,\ SPR_t) + d_1\ GI_i + d_2\ C_t + d_3\ C_t{*}GI_i + v_{it} \qquad (5)$$

With Y_{it} one of the nine balance-sheet ratios, c(.) a non-linear function of its exogenous arguments, and d_1, d_2 and d_3 the difference-in-difference coefficients. The average impact of global-impulse on the balance-sheet choice variables over the entire period is given by d_1. The average difference between balance sheet shares for the crisis period relative to the non-crisis periods is given by d_2. The coefficient d_3 then indicates the incremental difference between banks with global impulse and other banks in times of crisis. We assume that v_{it} is an independently and identically distributed zero-mean normal error. The function c(.) includes the panel variables s_{it} and A_{it} as well as bank-specific characteristics.

Our null hypothesis in these regressions is that the systematic variation in balance-sheet choice variables is completely explained by the characteristics summarized in the c(.) function. Our alternative hypotheses to be tested are that bank balance-sheet allocations will vary significantly and systematically on average in comparing (a) the pre-crisis period to the crisis period and (b) banks with global impulse to banks without that impulse. We will use the estimated coefficients

d_1, d_2, and d_3 to test these hypotheses. If d_1 is statistically significant, for example, we conclude that the global-impulse balance-sheet shares are significantly different on average than for banks without the global impulse. (These results should be quite similar to the result we obtained for the pre-crisis sample in Tables 5 and 6.) While we are examining nine balance-sheet allocations, we expect the significant differences to emerge in the cross-border financial flows – in the interbank and within-bank lending and borrowing. If d_2 is statistically significant, we will conclude that banks' choices of balance-sheet shares were significantly different on average when comparing the non-crisis to crisis periods. If d_3 is statistically significant, we will conclude that the banks with global impulse had a statistically different choice on balance-sheet share than those without global impulse during the crisis period 2008-2010.

Table 8 reports the difference-in-difference estimations for the 2002:q1 to 2010:q4 period for five balance-sheet shares. Once again, exogenous bank characteristics and financial risk are found to be significant in most cases. The coefficients d_1 (the GI_i coefficients) for the five regressions reported here are very similar quantitatively and identical in terms of statistical significance to those reported in Table 5. Our estimates for the coefficient d_2 (the C_t on balance-sheet shares) indicate that balance-sheet shares for leverage, liquid assets, non-performing loans and deposits fell significantly between crisis and non-crisis periods. The equity share in the crisis period is reduced on average, but the coefficient is statistically insignificant. (The significant fall in leverage suggests that this equity effect may have in fact been positive.)

Table 8 also reports the coefficients d_3 (the GI_i*C_t coefficients) that indicate the direction of adjustment in these five balance-sheet shares by banks of global impulse relative to banks without such impulse. This measure indicates that banks of global impulse did not adjust their balance-sheet choices significantly differently from other banks during the crisis period in the areas of equity shares, liquid assets and deposits. There were two significantly different adjustments to crisis: global-impulse banks reduced leverage relatively more, and they reduced their non-performing loan share of total assets by relative more.

Table 9 reports the result of these difference-in-difference estimations for interbank lending and borrowing. All of the exogenous variables are found to contribute significantly: most notably, increases in our spread-based measure of market uncertainty lead to reductions in both borrowing and lending. The d_1 coefficient, once again, nearly duplicates the positive GI_i effects observed in Table 6: banks of global impulse participated relied more upon interbank markets for both assets and liabilities in the pre-crisis period. The d_2 coefficients indicate that on average, banks increased their reliance on interbank borrowing and lending in their balance sheets during the crisis.

The d_3 coefficients indicate the difference-in-difference (GI_i*C_t) change in banks with global impulse. We observe a quantitatively large and statistically significant reduction in the shares of interbank lending and borrowing on the balance sheets of banks of global impulse relative to banks without such impulse. This is a direct test, and an affirmation, of the Cetorelli/Goldberg hypothesis.

There is a final open question about the crisis: while the global banks were reducing reliance on interbank lending and borrowing, were they increasing reliance on within-bank lending and

borrowing? We examine this question in Table 10. We use a similar regression structure. It is not a difference-in-difference test, since only global banks will have within-bank transactions, but we are able to examine the balance-sheet shares of within-bank lending and borrowing over pre-crisis and crisis periods while controlling for exogenous variables. We have a much smaller number of observations, since we are limiting the analysis to global banks. Regulatory variables are found to be significant in within-bank borrowing and lending regressions, while financial uncertainty proves to be insignificant. There is in fact an up-tick in the balance-sheet share of within-bank lending and borrowing during the crisis period for global banks. However, the difference from non-crisis to crisis is not statistically significant. Although the crisis dummy is not found to be significant in these regressions, the positive sign of this variable implies an increase in the within-bank transactions in response to the financial crisis. The quantitative share is in both borrowing only a small share of the excess reduction in interbank lending and borrowing by these global banks.

5. Conclusions.

Global banks have received a great deal of attention recently in the academic literature, in large part because of their posited contribution to the global financial crisis as channels of international transmission of the effects of the crisis. We've note a number of important contributions in recent years that find empirically that global banks did in fact play a central role in crisis transmission and adjustment.

We begin from the empirical fact that global banks tend to be large banks. This makes it impossible to disentangle the effect of being global from the size effect in exploring the characteristics of global banks. In this paper, we introduce a new way of separating the effect of global status from the size effect by introducing the concept of the "global impulse" and compare the characteristics of banks with global impulse to banks without it.

We disentangle the size effect through both non-parametric and parametric modeling of the transition to global status with increased size. There is a clear and statistically significant tie between increased size and global status, taking an exponential form for larger and larger banks. This statistical relation is treated as the propensity to "go global", and we use the difference between global status and this propensity as our indicator of global impulse.

Our analysis demonstrates that it is necessary to view global banks in the pre-crisis period to understand their contribution to the crisis period. Banks with global impulse made significantly different choices from banks without global impulse even in the pre-crisis period. They had larger equity shares on the balance sheet and used deposits more intensively among liabilities in financing their activities. Their share of liquid assets among total assets was also significantly lower than for non-global banks. The banks of global impulse also relied on interbank lending and borrowing in the pre-crisis period to a greater extent – from 2 to 4 percent of total assets more than with banks without global impulse.

The crisis had a negative effect on average on most observed balance-sheet shares: leverage was reduced, liquid asset shares were reduced, non-performing loans as a share of total loans were reduced, deposits as a share of total liabilities were reduced. Interbank lending and borrowing as a share of total assets rose. These are all effects on average – combining banks with and without global impulse.

When taken in isolation, we observe that banks with global impulse responded to the crisis significantly differently in having greater reductions in leverage and in non-performing loan shares. The global impulse is also associated with reductions in both interbank borrowing and interbank lending during the crisis period. However, these effects work mainly to reverse the size of the global banks' greater reliance upon the interbank markets observed in the pre-crisis period.

Did the global banks replace interbank borrowing with their within-bank borrowings, or interbank lending with within-bank lending? There is inconclusive evidence of that. It is significant, though that the crisis period represented a retrenchment of the global banks – their pre-crisis greater reliance on interbank borrowing and lending was mostly erased by their adjustments during the crisis period.

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Figure 1: (Global banks right axis)

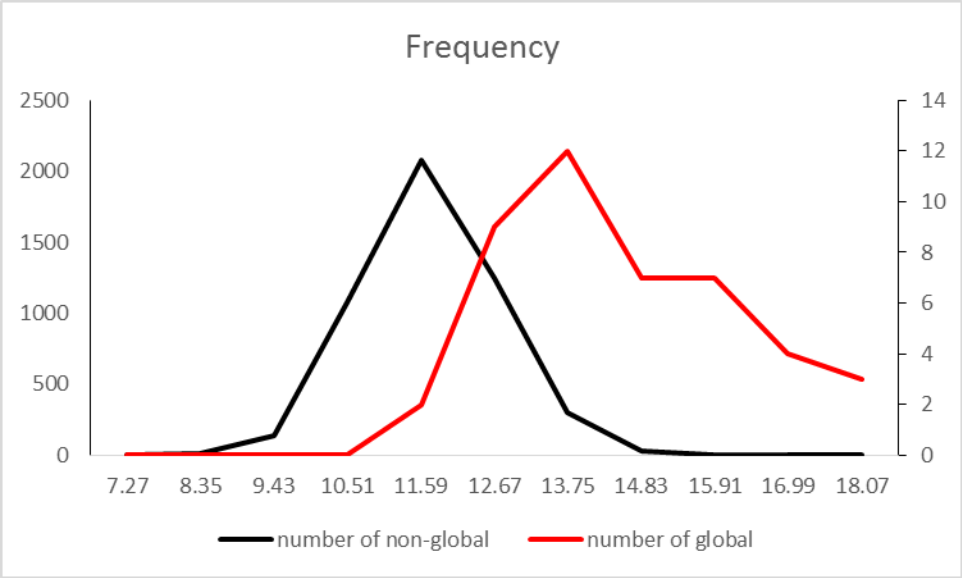

Figure 2: Local Polynomial Smooth as of 2001:q1

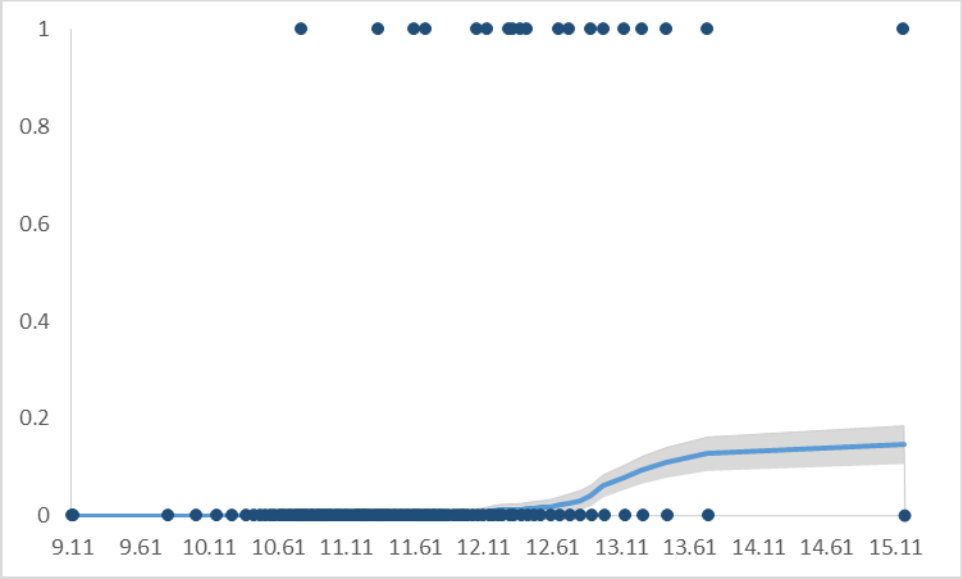

Figure 3: The size-dependent $\phi(s_{it})$ and parametric $f(s_{it})$

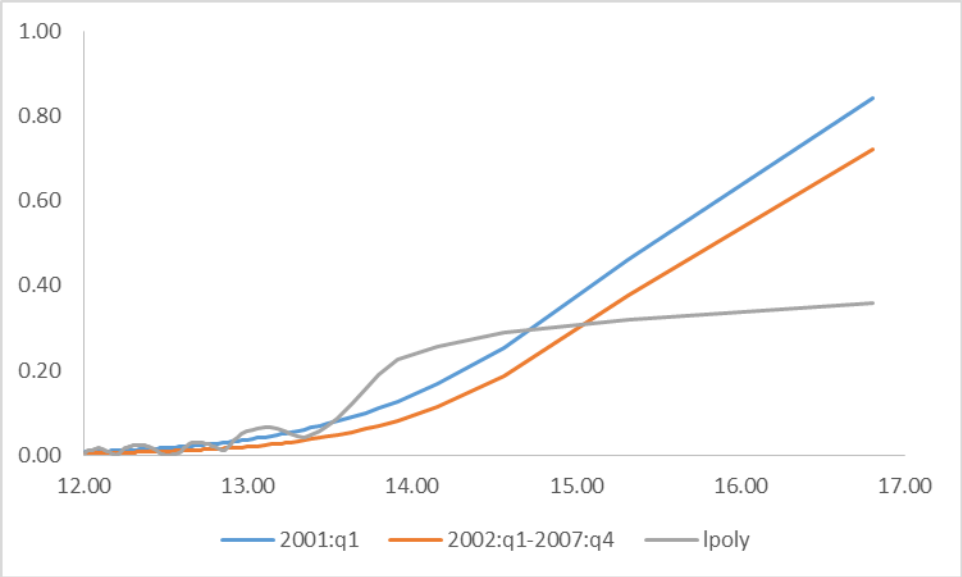

Table 1: Basic Statistics of all Banks (2001-2007)

	Global	Banks				Non-Global	Banks			
Variable	Obs	Mean	Std Dev.	Min	Max	Obs	Mean	Std Dev.	Min	Max
O_i	44	0.39	0.49	0.00	1.00	3906	0.23	0.42	0.00	1.00
F_i	44	0.13	0.33	0.00	1.00	3906	0.11	0.30	0.00	1.00
$FDIC_i$	44	0.48	0.50	0.00	1.00	3906	0.66	0.47	0.00	1.00
H_i	44	0.35	0.47	0.00	1.00	3906	0.14	0.33	0.00	1.00
HH_i	44	0.14	0.34	0.00	1.00	3906	0.06	0.21	0.00	1.00
S_{it}	44	14.19	1.72	11.44	18.28	3906	11.76	0.81	9.13	17.63
A_{it}	44	28.00	0.00	28.00	28.00	3906	28.00	0.00	28.00	28.00
E_{it}	44	13.22	9.69	3.70	50.68	3906	10.54	3.80	5.52	81.91
L_{it}	44	9.10	4.63	0.97	26.06	3906	9.18	2.31	0.22	17.10
LA_{it}	44	3.87	6.41	0.00	29.52	3906	4.04	8.88	0.00	85.00
N_{it}	44	1.23	1.35	0.00	6.53	3903	0.97	0.95	0.00	12.77
D_{it}	44	80.76	15.98	31.06	97.70	3906	92.61	8.61	0.00	99.89
IB_{it}	44	5.92	8.13	0.00	29.88	3906	1.38	3.67	0.00	70.74
IL_{it}	44	8.58	15.18	0.00	82.15	3906	3.75	4.08	0.00	62.72
WB_{it}	37	5.57	10.83	0.00	60.83					
WL_{it}	37	2.18	4.11	0.00	17.99					

(I did not change Table 1. Please let me know if you want me to cover 2002-2007 period in this table)

Table 2: Basic Statistics of Banks (2008-2010)

	Global Banks					Non-Global Banks				
Variable	Obs	Mean	Std Dev.	Min	Max	Obs	Mean	Std Dev.	Min	Max
O_i	44	0.41	0.50	0.00	1.00	4107	0.21	0.41	0.00	1.00
F_i	44	0.11	0.32	0.00	1.00	4107	0.12	0.32	0.00	1.00
$FDIC_i$	44	0.48	0.51	0.00	1.00	4107	0.67	0.47	0.00	1.00
H_i	44	0.37	0.47	0.00	1.00	4107	0.15	0.35	0.00	1.00
HH_i	44	0.16	0.35	0.00	1.00	4107	0.06	0.22	0.00	1.00
S_{it}	44	14.57	1.74	11.66	18.94	4107	12.01	0.89	8.47	18.45
A_{it}	44	12.00	0.00	12.00	12.00	4107	12.00	0.00	12.00	12.00
E_{it}	44	12.14	7.45	5.85	44.87	4107	10.61	4.00	4.16	91.82
L_{it}	44	9.03	3.60	1.23	16.08	4107	9.15	2.43	0.09	23.04
LA_{it}	44	2.55	3.88	0.00	17.07	4107	2.92	7.67	0.00	82.47
N_{it}	39	2.50	2.03	0.00	9.90	4102	2.32	2.34	0.00	26.45
D_{it}	44	84.50	13.25	40.16	98.96	4107	92.31	8.58	0.00	99.94
IB_{it}	39	4.28	6.30	0.00	26.59	4105	1.33	3.77	0.00	84.18
IL_{it}	39	2.73	4.51	0.00	24.65	4105	2.56	3.34	0.00	89.09
WB_{it}	36	8.74	14.81	0.00	72.63					
WL_{it}	36	0.90	2.29	0.00	11.53					

Table 3: Probit estimations for likelihood of a global bank

	2001q1		2002q1- 2007q4	
	Coef.	Std. Err	Coef.	Std. Err
S_{it}	-2.44	21.72	-11.15	3.24
S_{it}^2	0.21	1.53	0.83	0.22
S_{it}^3	0.00	0.04	-0.02	0.01
_cons	4.56	102.40	45.04	15.55
N	948		34,155	
Pseudo R2	0.26		0.273	

Table 4: ATE Estimations of the impact of being a global bank during the pre-crisis period (2002q1-2007q4)

	Coef.	Std. Err.	z	# of Obs
E_{it}	3.25	0.59	5.49	34,155
L_{it}	-51.96	37.24	-1.4	34,155
LA_{it}	-0.15	0.34	-0.44	34,154
N_{it}	0.97	0.32	2.99	33,961
D_{it}	-0.19	0.55	-0.36	34,155
IB_{it}	0.05	0.19	0.25	34,019
IL_{it}	8.09	2.40	3.37	34,019

Table 5: Balance-sheet share estimations for pre-crisis period (2002q1 – 2010q4)

	E_{it}		L_{it}		LA_{it}		N_{it}		D_{it}	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
O_i	-0.33***	(0.05)	16.13***	(3.34)	-1.21***	(0.09)	0.08***	(0.02)	0.11	(0.13)
F_i	-0.63***	(0.05)	34.00***	(4.18)	-0.99***	(0.12)	-0.04*	(0.02)	-1.05***	(0.20)
H_i	1.00***	(0.16)	0.37	(7.18)	-0.91***	(0.12)	-0.14***	(0.02)	-5.25***	(0.39)
HH_i	-1.75***	(0.16)	50.09***	(8.45)	0.84***	(0.20)	0.10***	(0.03)	4.04***	(0.45)
SPR_t	0.05	(0.04)	-0.43	(2.39)	0.03	(0.08)	0.03**	(0.01)	-0.44***	(0.09)
S_{it}	-78.96***	(10.22)	1403.42*	(588.53)	-14.21	(16.29)	-5.33*	(2.32)	208.57***	(33.09)
S_{it}^2	5.39***	(0.73)	-84.82*	(41.61)	1.08	(1.14)	0.31	(0.17)	-14.49***	(2.36)
S_{it}^3	-0.12***	(0.02)	1.63	(0.97)	-0.03	(0.03)	-0.01	(0.00)	0.32***	(0.06)
A_{it}	0.01	(0.01)	-0.62	(0.52)	-0.08***	(0.02)	-0.00	(0.00)	-0.08***	(0.02)
GI_i	2.44***	(0.38)	-29.51	(16.04)	-1.51***	(0.30)	0.37***	(0.08)	2.93***	(0.65)
_cons	389.71***	(47.58)	-6507.49*	(2751.11)	63.79	(76.64)	29.98**	(10.72)	-877.53***	(153.68)
N	34155.00		34155.00		34154.00		33961.00		34155.00	
r2	0.03		0.01		0.02		0.01		0.17	
F*	49.00		37.38		44.67		30.16		242.89	

* p<0.05, ** p<0.01, *** p<0.001.

Table 6: Interbank lending and borrowing in pre-crisis period (2002q1 – 2007q4)

	IB_{it}		IL_{it}	
	Std. Err	Coef.	Std. Err	Coef.
O_i	0.98***	(0.07)	0.68***	(0.07)
F_i	1.72***	(0.14)	0.40***	(0.09)
H_i	2.86***	(0.19)	1.09***	(0.19)
HH_i	-0.98***	(0.25)	-0.76***	(0.22)
SPR_t	0.15**	(0.05)	-0.31***	(0.05)
S_{it}	-151.69***	(10.87)	-111.61***	(10.46)
S_{it}^2	10.94***	(0.76)	7.57***	(0.73)
S_{it}^3	-0.26***	(0.02)	-0.17***	(0.02)
A_{it}	0.03***	(0.01)	-0.10***	(0.01)
GI_i	1.93***	(0.33)	4.34***	(0.62)
_cons	690.56***	(51.06)	545.92***	(49.21)
N	34019.00		34019.00	
r2	0.10		0.04	
F*	143.94		65.59	

Table 7: ATE Estimation of the impact of being a global bank (2008q1-2010q4)

	Coef.	Std. Err.	z	# of Obs
E_{it}	5.63	0.58	9.74	22,957
L_{it}	-327.66	19.86	-16.5	22,957
LA_{it}	-0.65	0.27	-2.39	22,952
N_{it}	0.01	1.10	0.01	22,845
D_{it}	-1.10	1.20	-0.92	22,957
IB_{it}	-0.43	0.17	-2.47	22,897
IL_{it}	7.33	5.52	1.33	22,897

Table 8: Difference in Difference Estimations for balance-sheet share choices (2002q1-2010q4)

	E_{it}		L_{it}		LA_{it}		N_{it}		D_{it}	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
O_i	-0.33***	(0.04)	4.91	(4.32)	-1.02***	(0.07)	0.01	(0.02)	0.33**	(0.10)
F_i	-0.60***	(0.04)	24.02***	(5.06)	-0.80***	(0.09)	-0.12***	(0.03)	-1.17***	(0.15)
H_i	1.39***	(0.12)	-41.98***	(5.84)	-0.70***	(0.09)	-0.28***	(0.03)	-4.96***	(0.28)
HH_i	-1.93***	(0.13)	78.16***	(7.10)	0.67***	(0.15)	0.17***	(0.04)	3.81***	(0.33)
SPR_t	-0.00	(0.02)	10.12***	(2.43)	0.11***	(0.03)	0.40***	(0.01)	0.51***	(0.05)
S_{it}	-60.89***	(6.24)	1899.27***	(438.62)	2.51	(10.29)	-2.59	(2.35)	186.98***	(21.10)
S_{it}^2	4.12***	(0.44)	-121.13***	(30.61)	-0.17	(0.72)	0.17	(0.16)	-13.03***	(1.49)
S_{it}^3	-0.09***	(0.01)	2.52***	(0.71)	0.00	(0.02)	-0.00	(0.00)	0.29***	(0.03)
A_{it}	0.00	(0.00)	2.17**	(0.74)	-0.06***	(0.01)	0.08***	(0.00)	0.14***	(0.01)
C_t	-0.13	(0.09)	-27.93**	(10.64)	-0.38*	(0.17)	-0.13**	(0.04)	-2.15***	(0.24)
GI_i	2.42***	(0.38)	-24.16	(16.08)	-1.54***	(0.30)	0.41***	(0.08)	2.91***	(0.66)
GIi*Ct	-0.14	(0.56)	-54.18*	(25.82)	0.46	(0.45)	-0.62***	(0.17)	0.27	(1.16)
_cons	305.81***	(29.29)	-8814.50***	(2081.01)	-10.32	(48.60)	11.81	(11.14)	-779.99***	(98.90)
N	57110.00		57110.00		57106.00		56806.00		57112.00	
r2	0.03		0.00		0.02		0.16		0.15	
F*	64.79		25.83		65.12		592.25		327.38	

Table 9: Difference in Difference Estimation for interbank lending and borrowing (2002q1-2010q4)

	IB_{it}		IL_{it}	
	Std. Err	Coef.	Std. Err	Coef.
O_i	1.05***	(0.05)	0.48***	(0.05)
F_i	1.63***	(0.10)	0.34***	(0.06)
H_i	2.83***	(0.15)	0.97***	(0.13)
HH_i	-1.21***	(0.19)	-0.68***	(0.14)
SPR_t	-0.12***	(0.02)	-0.28***	(0.02)
S_{it}	-126.76***	(8.30)	-74.64***	(6.41)
S_{it}^2	9.08***	(0.58)	4.97***	(0.45)
S_{it}^3	-0.21***	(0.01)	-0.11***	(0.01)
A_{it}	-0.03***	(0.01)	-0.09***	(0.00)
C_t	0.18	(0.13)	0.78***	(0.12)
GI_i	1.89***	(0.34)	4.32***	(0.62)
GIi*Ct	-2.70***	(0.54)	-2.92***	(0.80)
_cons	581.57***	(39.22)	372.19***	(30.35)
N	56916.00		56916.00	
r2	0.10		0.05	
F*	175.19		168.32	

Table 10: Difference estimation for within-bank lending and borrowing

	WB_{it}		WL_{it}	
	Std. Err	Coef.	Std. Err	Coef.
O_i	-4.39***	(0.77)	0.16	(0.26)
F_i	-1.84	(1.04)	2.93***	(0.35)
H_i	-1.20	(1.04)	0.57	(0.42)
HH_i	0.35	(0.84)	-2.98***	(0.35)
SPR_t	-0.24	(0.44)	0.04	(0.09)
S_{it}	-100.51***	(30.33)	12.11	(10.83)
S_{it}^2	6.32**	(2.00)	-0.62	(0.72)
S_{it}^3	-0.13**	(0.04)	0.01	(0.02)
A_{it}	0.09	(0.10)	-0.08**	(0.03)
C_t	1.58	(2.34)	0.36	(0.50)
_cons	532.55***	(152.19)	-71.52	(54.12)
N	1229.00		1229.00	
r2	0.04		0.11	
F*	11.34		21.91	

Data Appendix: variables used in the regressions.

Dependent variables:

TA_{it}: Total Assets

E_{it}: Total equity capital/TA_{it}

Total Liability: Total assets – equity.

IB_{it}: Federal funds purchases in the interbank market/TA_{it}. It is calculated as the summation of federal funds purchases in domestic offices and securities sold under agreements to repurchase.

IL_{it}: Federal funds sold in the interbank market/TA_{it}. It is calculated as the summation of Federal funds sold in domestic offices, and securities purchased under agreements to resell.

WB_{it} :Parent banks' borrowing from their foreign subsidiaries/TA_{it}.

WL_{it}: Parent banks' lending to their foreign subsidiaries/TA_{it}.

LA_{it} : Liquid Assets/TA_{it} : It includes securities that are held to maturity, total trading assets, federal funds sold in domestic offices and securities purchased under agreements to sell.

N_{it}: Nonperforming Loans/Total Loans. Non-performing loans are "Total loans and lease financing variables that are nonaccrual and that are past due 90 days or more or still accruing"

Independent variables:

C_t: A dummy variable taking a value of 1 for crisis years which are taken to be 2008, 2009 and 2010 and the value 0 otherwise.

G_i: A dummy variable taking a value 1 for global banks and 0 otherwise,

O_i: Dummy variable that takes the value of 1 if the bank is regulated by the OCC and 0 otherwise.

F_i: Dummy variable that takes the value of 1 if the bank is regulated by the Fed and 0 otherwise.

H_i: A dummy variable that takes the value of 1 if the bank is owned by a bank holding company and zero if it is an independent bank.

HH_i: A dummy variable is equal to one if the bank is the lead holding company (the one with largest assets in a bank holding company) and 0 otherwise.

S_{it}: Log of total assets.

Downloaded from the Federal Reserve's Consolidated Reports of Condition and Income:
RSSD9001: The primary identifier of a bank,
RSSD9999: The quarter for which the report was filed,
RCFD2170: Total assets,
RCFD3210: Equity capital,
RCFDb993: Federal funds purchased in domestic offices,
RCFDb995: Securities sold under agreements to repurchase,
RCFDb987: Federal funds sold in domestic offices,
RCFDb999: Securities purchased under agreements to resell,
RCON2391: Net due to own foreign offices, edge and agreement subsidiaries, and IBFS,
RCON2163: Net due from own foreign offices, edge and agreement subsidiaries, and IBFS,
RCFD1407: Total loans and lease financing variables past due 90 days or more or still accruing.
RCFD1403: Total loans and lease financing variables nonaccrual,
RCFD1754: Total Held-to-maturity securities,
RCFD3545: Total trading assets,
RSDD9421: A code indicating authority charter,
RSDD942: A code indicating the Federal Reserve membership status of an entity.
RCFN2170: Net foreign assets.

Filters Applied

The data are downloaded from the quarterly Call Reports for 2001:Q1 to 2010:Q4 period. We applied the following filters to the data:
-We eliminate bank-quarters in which total assets or deposits or bank capital or total loans are not available.
-We eliminate banks whose observations are not available for the whole sample.
-We determine the global position of banks based on the value of net foreign assets. A bank that has positive net foreign assets at least one time in our time period is accepted to be a global bank. We eliminate banks whose net foreign asset value changes between not available, zero and a positive number more than two times.
-We eliminate all non-global banks that are smaller than the smallest global bank.
After these filters are imposed, 148,663 observations and 100,871 observations remain in the sample for 2001-2010 and 2001-2007 periods respectively.