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Bank globalization and the balance sheet channel of monetary transmission

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Abstract

The literature typically finds that the development of financial markets has decreased the ability of central banks to affect the real economy. This paper shows that this negative relationship does not hold for the balance sheet channel of monetary transmission and bank globalization – one aspect of financial development. The reason is that global banks are more sensitive to borrowers' leverage. By affecting this leverage, monetary policy has a larger impact on global banks' lending and aggregate economic activity. We use bank-level, Call Report data to obtain this disparity between more and less global banks. We then use this data in the estimation of a general equilibrium model and find that the balance sheet channel of monetary policy operates mainly through more global banks.

Journal of Economic Literature Classification: E44, F31, F41, O16

Keywords: balance sheet channel, bank globalization, financial accelerator

1. Introduction

The balance sheet and the lending channels of monetary transmission are agreed to be the two important ways in which the Federal Reserve Bank (FED), by affecting short term interest rates, can have a non-negligible impact on the real variables in the economy (c.f. Bernanke and Gertler, 1995). Both of these channels operate through bank lending. According to the balance sheet channel of monetary transmission (BSCMT), monetary policy, by affecting borrowers' financial leverage and thus credit worthiness, can affect the demand for loans. Vice versa, the lending channel of monetary transmission (LCMT) becomes operative when the FED changes the level of reserves in the economy and affects the cost of raising deposits and thus the supply of loans. Research that gages the strength of the lending channel is ample and mostly finds that the FED's ability to affect the real economy through the lending channel has diminished over time (c.f. Kashyap and Stein, 2000). This is mostly attributed to the financial development and innovation that has decreased banks' cost of raising loanable funds. Research on the BSCMT in contrast, is relatively scarce mainly due to difficulties in identifying the independent effects of this channel.

Recently, the globalization of banking operations has been one noticeable feature of the financial development in the world. Figure 1 displays this trend and shows that the growth in the external assets and liabilities of Bank of International Settlements (BIS) reporting banks has considerably outpaced the growth in world GDP over the past decade.[1] Understanding how monetary transmission operates with more global banks is thus an important challenge in the current monetary economics literature. In a recent paper, Cetorelli and Goldberg (2009) emphasize the importance of globalization for monetary transmission and find that the

[1] Data on the components of the total external assets and liabilities indicate that the majority of the trends in these variables are determined by loans and deposits and not by the holdings of securities. This data are only available after 1995 and therefore not included in the graph.

globalization of banking has had a negative effect on the LCMT since global banks, through their access to internal funds, are more insulated from the liquidity conditions in the U.S. economy.

In this paper, we empirically identify the BSCMT by using the methodology of Ashcraft and Campello (2007) and measure the strength of this mechanism for more global banks (MGB) and less global banks (LGB). The results indicate a positive relationship between bank globalization and the BSCMT. Overall, these results are important since they suggest that the negative relationship observed between the LCMT and financial development may not hold between the other channels of monetary transmission and at least one aspect of financial development, i.e., bank globalization.

The empirical analysis is conducted using bank-level data from the Call Reports of U.S. chartered banks for the period 1986:2 through 2009:1. One advantage of this dataset is the large number of bank level observations. Indeed, together with the long time series, we are able to use over 1 million observations in estimation. To construct the dataset, we follow three key steps. First, to neutralize the liquidity constraints that banks face and to measure the effects of the balance sheet channel that are independent of the lending channel, we compare how the subsidiaries that are affiliated with the same bank holding company (BHC) react to changes in borrowers' balance sheet strength. Second, given the absence of loan-level data, we proxy the strength of balance sheets that a bank faces by using the GDP gap in the state that the bank operates in. Third, we classify BHCs into MGB and LGB based on their loans of foreign offices to total loans ratios. We then use this constructed dataset in a two step estimation methodology, similar to that of Kashyap and Stein (2000) to estimate the BSCMT. To do so, we estimate the sensitivity of banks loans (relative to the other banks affiliated with the same BHC) to state GDP gaps in each quarter. We then include the estimated sensitivities as the dependent variable in a second stage regression to measure the effects of monetary policy on this generated variable. We follow this two step estimation strategy separately for banks that are affiliated with more and less global BHCs respectively. The estimation results, in general, demonstrate a stronger BSCMT for MGB. Specifically, monetary policy has a larger effect on MGB' sensitivity to balance sheets compared to its effects on LGB.

Besides the complications in measuring balance sheet strength, there are two main difficulties that can confound the analysis. *First,* although the stance of monetary policy is typically measured by using the federal (Fed) funds rate (nominal and real), most of the variation in these may reflect the reaction to other macroeconomic variables, and the identification of the variation in monetary policy tools that are due to monetary policy shocks alone can be far from straightforward. Moreover, the long sample period adds another layer of complexity given the different formulations of monetary policy during the past 30 years. *Second*, the disparity between MGB and LGB could be due to bank characteristics other than the degree of globalization. For example, the dataset shows that MGB are considerably larger than LGB. Given these risks, we take several steps to check the soundness of our baseline results. First, we use 5 different measures of monetary policy stance, other than the real and nominal FFR, that are commonly used to capture the variation in the monetary policy tools that is independent of the shocks to macroeconomic variables. To ensure that the results are not driven by banks' size, besides including banks' size as an independent variable, we impose the size distribution of MGB on LGB. We also investigate whether other characteristics play a role by using a historical analysis. The results, although mixed, generally indicate a positive relationship between globalization and the BSCMT.

The empirical methodology followed in this paper allows us to compare the effects of monetary policy on the leverage sensitivity of MGB and LGB; but the BSCMT operates not only through banks' sensitivity to borrowers' leverage, but also through leverage itself. To capture and quantify the overall effects of the BSCMT therefore, we construct a general equilibrium model characterized by the financial accelerator mechanism of Bernanke et al. (1999); this mechanism is designed and often used to identify the BSCMT. We then embed this mechanism into a dynamic New-Keynesian (DNK) framework - similar to Smets and Wouters (2007) -. Different from these commonly used frameworks, we include two types of banks: MGB and LGB. We then estimate the parameters of this model using a Bayesian methodology. To estimate the model, we use data on the loans of MGB and LGB in addition to the commonly used macroeconomic variables. This is one unique feature of the paper since it allows us to estimate the leverage sensitivity parameter separately for the two groups of banks and to explore the quantitative significance of this disparity for output. Consistent with the empirical results, the sensitivity of MGB are considerably (approximately 3 times) larger than the sensitivity of LGB. The conclusions drawn from the impulse responses and historical decompositions (HD) are also similar: the BSCMT mainly operates through MGB.

Although it is very difficult to compare the strength of these channels and draw inferences for overall monetary policy effectiveness, the empirical results together with a diminishing LCMT certainly justifies a closer investigation of the relationship between central bank effectiveness and financial development. The results are also consistent with studies that investigate FDI in the financial sector, which mostly find that MGB are more sensitive to their borrowers' financial leverage.[2] Some of the different explanations for this disparity are that MGB' loans have shorter maturity and the banks do less relationship lending (house-bank

[2] c.f. Buch (2005), Berger et al. (2001), Berger et al. (2000), and Clarke et al. (2003).

lending). Although testing the validity of these explanations is beyond the scope of this paper, we show that this difference is important for one key channel of monetary transmission.

The rest of the paper is organized as follows: Section 2 discusses the empirical evidence for the relationship between bank globalization and the BSCMT. Section 3 describes the DSGE model that is estimated to quantify the effect of globalization on the BSCMT. Section 4 concludes.

2. Empirical Evidence

As discussed above, one important challenge in this paper is to identify the effect of monetary policy on bank lending via the balance sheet channel (demand for loans) that is independent of its effects on loans through the lending channel (supply of loans). Although this is a difficult task, especially given the lack of loan-level data, the identification strategy of Ashcraft and Campello (2007) provides a convenient setup. In this section, we describe how we extend this empirical methodology to measure and compare the strength of the BSCMT that operates through MGB and LGB, describe how the data set is constructed and discuss the estimation results.

Identification Strategy

Using the constructed dataset (described below), we measure the BSCMT for MGB and LGB by following five main steps. *First*, we identify banks that are the subsidiaries of the same BHC. We then measure the deviation of the banks' loan growth from the mean value of loan growth measured across all the banks that are affiliated with the same BHC. Let lg_{ijt} denote the growth rate of bank *i*'s loans in period *t* (over the previous quarter) and $\overline{\mathrm{lg}}_{jt}$ denote the average loan growth rate of of the banks affiliated with the BHC *j*, the deviation of bank *i*'s loans is measured as,

$$ld_{ijt} = \lg_{ijt} - \overline{\lg}_{jt} \tag{1}$$

This critical step provides a reasonable way to exclude the effects that a bank's liquidity limitations may have on its supply of loans. Indeed, to the extent that the parent BHC provides funds to its subsidiaries through internal capital markets (as indicated by empirical evidence), the subsidiaries are subject to the same liquidity constraints and the variable ld_{ijt} excludes these constraints (and any effect that monetary policy may have on these constraints) from the factors that may affect the supply of loans. We follow a similar approach in constructing the control variables and measure the deviation of a set of bank specific variables from their BHC averages (denoted by cd_{ijt}).

Second, we identify the states that banks operate in and approximate the relative strength of balance sheets using a measure of overall economic activity in the state. This variable is denoted by bs_{ijt}.

As a *third* step, we include these variables in the model below to measure the effect of balance sheet strength on the amount of loans extended separately for each quarter. Estimating this model for every quarter allows us to exclude the asymmetric effects that macroeconomic variables may have across banks over time. This is similar to the first step in the two-step estimation strategy of Kashyap and Stein (2000).

$$ld_{ijt} = \alpha + \sum_{k=1}^{4} \beta_{kt} ld_{ijt-k} + \sum_{k=1}^{4} \gamma_{kt} bs_{ijt-k} + \sum_{k=1}^{4} \nu_{kt} cd_{ijt-k} + \varepsilon_{ijt} \tag{2}$$

Notice that the coefficients of interest are γ_{kt} and the overall effect of balance sheets on loan growth (balance sheet sensitivity) is measured as $\gamma_t = \sum_{k=1}^{4} \gamma_{kt}$. We then stack the γ_t values to construct a time series of the balance sheet sensitivity variable.

Fourth, to measure the strength of the balance sheet channel (or the effect of monetary policy on the sensitivity of loan supply growth to the strength of balance sheets), we estimate the following model:

$$\gamma_t = \lambda + \sum_{k=1}^{8} \varphi_k mp_{t-k} + \sum_{k=1}^{8} \varpi_k \Delta \ln(gdp)_{t-k} + \sum_{k=1}^{3} \xi_k qd_k + \omega T_t + \eta_t \tag{3}$$

where mp_t, gdp_t, qd_k and T_t denote the stance of monetary policy, gross domestic product, quarter dummies and the time trend variable respectively. The strength of the balance sheet channel in equation (3) is approximated by $\sum_{k=1}^{8} \varphi_k$.

Finally, using the strategy discussed in the section below we classify banks into two groups: MGB and LGB. We then repeat the previous four steps for these two groups and compare the estimation results.

Data and descriptive statistics

In estimating equation (1), we use data from the Federal Reserve's Call Report of Condition and Income. These data are publicly available for every U.S. chartered bank. Table A.1 in Appendix A reproduces the definitions of the bank-specific variables obtained from this database and are included in our estimation. This bank-level data is available quarterly after 1976. However, since we use BHC data to classify banks into MGB and LGB (as detailed below) and since BHC data is only available before 1986, we use data from 1986Q2 through 2009Q1.

The database includes the identification number of the high holder BHC (RSSD 9348) which is a key variable that allows us to identify the subsidiaries of each BHC. We only include BHCs that have subsidiaries in at least two states since we measure the differences in personal income gaps of different states in which the BHC has subsidiaries (to measure ls_{ijt}). For each BHC, we measure the deviations of its subsidiaries variables from the BHC averages. To measure the dependent variable (quarterly loan growth), we use total loans and measure growth as log differences. The control variable vector cd_{ijt}, includes the log of assets, the equity ratio and the liquid assets to total assets ratio which are all measured as deviations from their BHC averages.

States' personal income gaps are used as proxies for overall economic activity and the strength of balance sheets in a state. The total state personal income data are available quarterly for every U.S state and territory, and are obtained from the Bureau of Economic Analysis. The states' personal income gaps are calculated using a Hodrick Prescott filter with a smoothing parameter equal to 1600.

In the baseline estimation of the second stage regression (equation 2), we measure the stance of monetary policy by using the nominal and real Fed Funds rates and the level of economic activity by the growth rate of real GDP. We do, however, test the robustness of the baseline results by including different measures of the monetary policy stance variable.

Globalization

The Call report data also allows us to classify banks as MGB and LGB. Specifically, the FFIEC 031 Consolidated Reports of Condition and Income for a Bank with Domestic and Foreign Offices include variables that can indicate the degree of foreign operations. To proxy the degree of globalization, we choose the loans of foreign offices (BHCK2122) to total loans ratio (BHCK1764). Of course banks also lend directly abroad (and not only through its foreign offices) but this amount is considerably smaller and thus is ignored.

It is important to note that we use globalization data at the BHC level to classify the banks into MGB and LGB. Specifically, we classify banks as more (less) global in every quarter, if its high holder BHC has a significant (insignificant) amount of global operations in that quarter.

To do so, we sort BHCs with respect to their foreign loan ratios, classify the top 45% of as MGB, exclude the 10% of the BHC (with intermediate ratios) and classify the bottom 45% as LGB. BHCs without any foreign operations are also classified under LGB. We replicate this procedure in every quarter.

Therefore, we assume that if a BHC is more global then its subsidiaries are more global as well. This convention however, could be a misrepresentation of the effects of globalization if a bank's sensitivity to borrowers' leverage is determined independent of its high-holding BHC. There are two reasons why we follow this approach. The more practical reason is that the number of banks that lend abroad (directly or through its subsidiaries) is very small. Although there are other variables (some of which are listed in Appendix A) that could indicate whether banks are global or not, these measures are not continuous and thus do not indicate the degree of globalization. Second and more importantly, there appears to be a consensus in the finance literature (c.f. Akhavein, 1997; Berger et al., 1995; Stiroh, 2000) that using BHC level data instead of bank-level data is a more accurate way of analyzing important business decisions such as risk taking. These studies argue that the managers of subsidiaries typically coordinate activities to optimize the performance of the BHC.

Some of the descriptive statistics of the dataset, constructed using this classification, are reported in Table 1. Although MGB are fewer than LGB, they are considerably larger. Therefore, it is important to identify the effects of globalization on the BSCMT that are independent of bank size. One other bank specific characteristic that may have an effect on the banks' sensitivity to balance sheets is the number of subsidiaries. Specifically, banks with more subsidiaries in different states could be more diversified and thus less sensitive to borrowers' balance sheets. Table 1 shows that the number of subsidiaries of MGB is not too different from LGB, and thus may have limited effects on the estimation results.[3] Finally, we can also observe that the ratio of the total assets of MGB to the total assets of all the banks is not small (33 percent); thus, the asymmetric effects that monetary policy may have on MGB can be economically significant.

Results

Table 2 displays the results from the estimation of the second stage equation (equation 2). The reported coefficient values represent the aggregate effect of monetary policy (denoted by $\sum_{k=1}^{8}\varphi_k$) on balance sheet sensitivity (denoted by γ_t). The numbers in the parenthesis are the *F-statistics* (corrected for heteroskedasticity and autocorrelation) used to test the joint significance of the monetary policy coefficients. The sample period for each regression is 1986Q2-2009Q1; thus, there are 92 observations for each regression. The estimates, with the exception of one, indicate that monetary policy has a significant, positive effect on balance sheet sensitivity. Specifically, the positive coefficients imply that balance sheet sensitivity increases during tight monetary conditions and decreases during loose monetary conditions. The coefficient values are significant in general despite the small sample size. The results were similar when output gaps and output gap deviations were used to generate the dependent variable in the first stage, and when nominal and real Fed Funds rates were used to measure the stance of monetary policy.

It is important to note at this point that using the mean value of the coefficients, estimated in the first stage, in the second stage and not accounting for their standard errors may lead to invalid inferences. This is more commonly known as the *generated regressors problem* in the literature. We report the estimation results from the model that includes first stage measurement

[3] The results were similar when the number of subsidiaries of the parent BHC was included in the first stage estimation.

errors in the top panel of Table 2.[4] Note also that, by including the measurement errors in the second stage, one gives more weight to years with more observations (and low measurement errors). In the sample, 1970's and early 1980's have larger number of observations and the coefficient standard errors are smaller for these years. Giving larger weights to these years would be a drawback considering the activity level of monetary authorities during this period. Therefore, we also report, in the bottom panel of Table 2, the estimation results that do not account for first stage measurement errors. A comparison of the estimates in the two panels suggests that monetary policy had more impact on balance sheet sensitivity in the 1990's and 2000's implying a stronger balance sheet channel of monetary transmission during these periods.

To measure the strength of the balance sheet channel separately for MGB and LGB, we classify the BHCs into two groups as discussed above and estimate the balance sheet sensitivity for each group. We then use the estimated sensitivity coefficient for each group in the second stage estimation. The results reported in Table 2 point to a stronger balance sheet channel for MGB. Specifically, the coefficient values are larger (and mostly more significant) for MGB. This contrast between the two groups is robust to considering first stage measurement errors and using output gaps or output gap deviations to generate the sensitivity variable.

A simple thought experiment uncovers the economic significance of these results. First, let's assume that there is a 100 basis point decrease in the Fed funds rate that is spread uniformly over 8 quarters. Second, let's assume that a certain state is experiencing a 1 percent increase in output. The coefficient values of -0.29 (estimated for MGB) and -0.02 (estimated for LGB) then indicate that the MGB in this state will increase their loans by 29 percent more than the rest of its parent BHC's subsidiaries. The corresponding increase for LGB in the same state is only 2 percent. Note also that although all the estimates are positive for LGB, they are mostly

[4] We accounted for the measurement error using the methodology of Gawande (1997).

insignificant. Therefore, the results indicate that the balance sheet channel of monetary transmission operates through MGB and that monetary policy has a smaller impact on LGB' balance sheet sensitivity. Given that the share of MGB' loans, similar to asset size, is not small (37 percent), the disparity between MBG' and LGB' sensitivity to balance sheets can have nontrivial macroeconomic effects.

Robustness

In this section, we check the robustness of the results in Table 2 and further investigate the nature of the relationship between bank globalization and the BSCMT. Specifically, we consider different measures for the monetary policy stance and the degree of globalization, control for size, and investigate the relationship between globalization and the BSCMT in different sub-periods. The results are summarized in Table 3.

<u>Different measures of monetary policy stance</u>

Although real and nominal Fed Funds rates have often been used to measure the stance of monetary policy in the literature, the variation in these variables can be explained by shocks to other variables in the economy such as output and prices. Acknowledging this endogenous component of monetary policy, researchers have constructed measures of monetary policy stance that capture the variation in monetary policy that is independent of other macroeconomic variables. In this section, we check whether the results in Table 2 are robust to using the alternative indices constructed by Bernanke and Blinder (1992), Christiano and Eichenbaum (1992), Strongin (1995) and Bernanke and Mihov (1998) and to using the orthogonal shocks to borrowed reserves as measures of monetary policy stance. We followed the methodology described in these papers to extend the indices to 2009:1.[5]

<u>Accounting for size</u>

[5] See Bernanke and Mihov (1998) for a description of how the indices are constructed.

As mentioned above, MBG are, on average, larger than LGB. Therefore, it is critical to test whether the different strengths of the BSCMT observed between the two groups is due to the different sizes of banks. Although size is controlled for in the first stage regression, the relationship between size and the BSCMT may not be of a parametric form. As an additional test in this section, we replicate the size distribution of MGB by choosing random samples that include LGB for each quarter.[6] Given that the number of LGB is significantly larger than MGB, we are able to draw 100 random samples from the pool of LGB. We measure the BSCMT for these random samples and report the average of the estimates.

The results displayed in Table 3 show the same disparity between the two groups. BSCMT is stronger for MGB even when compared to LGB of similar size. Although the sensitivities for larger, LGB are noticeably larger, they are still significantly smaller when compared with MGB. Given these considerable effects of size, we control for size using the same procedure in the rest of the robustness tests.

Degree of globalization

The measure for globalization used in this paper is a continuous variable. Using the two-step estimation strategy for the two groups of BHCs, however does not allow one to take advantage of this feature of the data. Although it is possible to follow a one-step approach and include the degree of globalization as an interactive variable to measure the effect of globalization on the BSCMT, the interpretation of these coefficient values would not be straightforward and these values cannot be compared with the baseline results. For consistency, we instead break the sample of MGB into two groups. The first group, G1 includes banks in the

[6] To match the size distribution of MGB, I determine the ranges of values for total assets that define 5 size groups with equal number of observations. When drawing random LGB, I match the number of observations in each group. As an alternative, I used a fixed interval of total asset values and determined the number of MGB in each group. I then matched the number of banks in each asset size group by choosing LGB with similar size. The results were similar although I was not able draw as many random samples.

top 40 percent of the size distribution of MGB. The second group, G2 includes banks in the bottom 40 percent of the size distribution of MGB. The results in Table 3 similarly indicate that the BSCMT is the strongest for MGB for all the measures of monetary policy stance.

<u>Excluding crisis periods</u>

The sample period covered in our baseline analysis includes periods marked by sharp drops in economic activity. Although the non-linearities that such large perturbations would confound the analysis for both MGB and LGB, the effects of these shocks on the two groups of banks can be asymmetric. Given their global scale of operations, it is possible for MGB to shift their operations to markets that are less affected from the recession in the U.S. economy.

To check the robustness of the baseline results, we exclude the periods 1990:Q3 to 1991:Q1 and 2007:Q3 to 2009:Q1 and estimate equation (1). The results in Table 3, similar to the baseline results, indicate that the BSCMT is stronger for MGB.

<u>Historical evidence</u>

As discussed above the rate of globalization of banks has increased considerably over the past 15 years. This rapid globalization gives us a unique way of testing whether the disparity between the BSCMT for MGB and LGB is due to the characteristics of these banks other than size. To test whether these characteristics are important, we proceed as follows. First, we classify banks into two groups as before but use the period 1994-2009 to determine the degree of globalization. We then estimate equation (1) similarly using data from these two groups. Next, we use data from 1978-1993 for the two groups of banks and estimate equation (1). The results are displayed in Table 3 show that the disparity between the BSCMT for the two groups of banks is only observed in the sub-period 1994-2009. The results from the earlier period, although mixed, do not point to a noticeable difference between the coefficient values of the two groups.

3. An estimated DSGE model

Using the empirical model, described by equations (1) and (2), we were able to test for the differences in the balance sheet sensitivities of MGB and LGB. The disparity we found however, does not help us quantify the significance of the BSCMT. To do so, one has to account for not only the sensitivity of banks to borrower balance sheets but also the effect that monetary policy may have on balance sheets. In this section, we build a DSGE model to quantify the BSCMT and measure the differences in the strength of the BSCMT that operates through MGB and LGB. Although we use different measures for monetary policy used in the empirical section, the DSGE model also provides a better framework for capturing the independent effects of monetary shocks.

Calibration and estimation are the two common methods used to draw quantitative implications from DSGE models. We choose to use a Bayesian methodology to estimate our model. In contrast to calibration exercises, Bayesian estimation allows one to account for parameter uncertainty and to deal with possible model misspecification and the absence of identification. The methodology requires one to state their prior beliefs (the mean value and the distribution) about the estimated parameters to compute the posterior mode and distribution of the parameters that best match the data provided. This is especially advantageous since the model in this paper includes non-standard parameters such as the sensitivity to balance sheet strength.

Our model follows a standard Dynamic New Keynesian (DNK) framework that includes the financial accelerator mechanism of Bernanke et al. (1999). We follow a DNK framework since it has price and wage stickiness that allow for effective monetary policy. The financial accelerator mechanism has become a standard tool in macroeconomics to investigate the balance sheet channel of monetary transmission, thus it is convenient for the analysis. We enrich this model in a straightforward way by allowing some banks to be more global than others. In a closed economy model, this is captured by allowing the two different types of banks to have different sensitivities to borrower balance sheets. By using this strategy, we are able to measure the different effects of monetary policy on MGB' and LGB' lending and capture the contributions of these two types of banks to the transmission monetary shocks to the real sector.

With the exception of equations describing the two types of banks, the rest of the model and the estimation strategy are very similar to that in Smets and Wouters (2007) and Gilchrist et al. (2009) and is thus deferred to Appendix B. In this section, we describe how we include the two types of banks in the model.

The financial accelerator framework is centered on the relationship between a bank and an entrepreneur. The entrepreneur rents capital to produce output but does not have enough net worth to self finance, and therefore has to borrow from a bank. The returns to capital for the entrepreneur are subject to idiosyncratic shocks and there are costs to monitoring bankrupt firms. This financial friction generates a wedge between the risk free rate and entrepreneurs' borrowing costs. Bernanke et al. (1999) show that this wedge depends on entrepreneurs' leverage as follows:

$$E_t r_{k,t+1} = r_t - E_t \pi_{t+1} + \chi(q_t + k_t - n_t), \tag{3}$$

where $E_t r_{k,t+1}$ and $r_t - E_t \pi_{t+1}$ are the expected return to capital and the real interest rate on household deposits. The external finance premium, therefore, is denoted by $\chi(q_t + k_t - n_t)$, where q_t, k_t, and n_t denote the price of capital, entrepreneurs' capital stock, net worth respectively, and χ is the monitoring cost (bankruptcy cost) parameter. Together with the following equation that describes the evolution of entrepreneurs' net worth, the financial accelerator mechanism adds two equations to an otherwise standard DNK framework.

$$n_t = \gamma_e n_{t-1} + E_{t-1} r_{k,t} + \frac{K}{N}\left(r_{k,t} - E_{t-1} r_t\right), \tag{4}$$

where γ_e and $\frac{K}{N}$ are the survival rate of the entrepreneur and the steady state capital to net worth ratio.[7]

We assume that there are two types of banks: MGB, type 1 and LGB, type 2. These banks lend to two groups of entrepreneurs. The contract these banks offer their clients and the evolution of entrepreneurs produces two external finance premiums given by,

$$E_t r_{jk,t+1} = r_t - E_t \pi_{t+1} + \chi_j (q_{jt} + k_{jt} - n_{jt}) + \varepsilon_{jk,t}\,, \tag{5}$$

where subscript *j* denotes the two types of banks (j=1,2 denotes MGB and LGB respectively). Corresponding, for the net worth of the entrepreneurs who borrow from MGB and LGB evolves as follows:

$$n_{jt} = \gamma_e n_{jt-1} + E_{t-1} r_{jk,t} + \frac{K}{N}\left(r_{jk,t} - E_{t-1} r_t\right). \tag{6}$$

While the price of capital and thus leverage could be different across these two groups of entrepreneurs, arbitrage ensures that expected returns to capital are the same across the two groups; hence,

$$E_t\left(r_{1k,t+1} - r_{2k,t+1}\right) = 0\,. \tag{9}$$

We assume that the outputs of the two types of entrepreneurs are used as intermediate goods to produce the final good (CES aggregate) by a wholesaler:

$$y_t = (\varsigma y_{1t}{}^{\rho} + (1-\varsigma) y_{2t}{}^{\rho})^{1/p}\,, \tag{10}$$

where y_{1t} and y_{2t} are the output of the two groups of entrepreneurs. ς and p denote the share of entrepreneurs that borrow from MGB and the elasticity of substitution parameter.

[7] Entrepreneurs do not survive with a positive probability. This modeling convention prevents entrepreneurs from becoming self sufficient.

Note that, we allow for the leverage sensitivity parameter χ to be different for each bank. To make this model operative and measure the different effects of monetary policy on these two groups of banks, one needs to estimate χ separately for each group. To do this, we use the dataset described in Section 3. Specifically, we use the average total loans of MGB and LGB as observed variables in our estimation to capture the total borrowing from each group ($b_{jt} = q_{jt} + k_{jt} - n_{jt}$). In doing so, we control for size effects by using the methodology in the previous section. Specifically, using 100 random draws, we select LGB to match the size distribution of MGB. We then calculate the average (across banks) amount of loans in each draw and then take the average across the random draws to obtain our observable variable. This methodology is one unique feature of the analysis in this paper (the details of which are discussed in Appendix B) and allows us to measure the strength of the BSCMT that operates through MGB and LGB.

Results

Figure 2 shows the impulse responses to a 100 basis point annualized increase in the Fed Funds rate. The shock, initially, leads to a drop in investment and the price of capital, thus decreasing entrepreneurs' net worth. In response, the bank charges a higher premium on loans which in turn amplifies the response to the interest rate shock. So far this is the standard outcome of a DNK model with the financial accelerator mechanism. More critical result for this paper is the different responses of the MGB and LGB. The MGB, more sensitive to monetary policy, increase the external finance premium by generating a larger drop in output. Comparing the maximum amplitudes, the drop in the output of the entrepreneurs that borrow from MGB is 2.8 times larger than the output of the entrepreneurs that borrow from LGB. The confidence intervals also indicate that the difference in the responses is also significantly different from zero. This is not an unexpected result given that the estimated mean value of the leverage sensitivity parameter χ is considerably (2.9 times) larger for MGB. As an alternative, we calibrate the share parameter ς to 0 and 1 respectively to simulate an economy with only MGB and LGB. The results displayed in Figure 2 similarly show that the drop in output in the economy with only MGB is significantly higher than in the economy with LGB only.

The Bayesian estimation allows us to further quantify the differences in the BSCMT for the two groups of banks by investigating the historical decomposition (HD) of variables. The focus in this section is on the percentage of the variance of output that is attributable to monetary policy shocks. To compare the strength of the BSCMT that operates through MGB and LGB, we obtain HDs from the economies that only include MGB and LGB separately. The results displayed in Figures 4 and 5, similar to the impulse responses, reveal that the BSCMT for MGB is considerably larger than the BSCMT for LGB. Indeed, if we compare simple averages, the percentage of the variance of output (in absolute value) that is attributable to monetary policy shocks in the economy with only MGB is approximately 3 times larger. The figures also demonstrate -- a less central result -- the contribution of financial shocks to the recent recession. Indeed, the contribution of financial shocks to output growth has turned negative starting with 2004 and these shocks caused a large decrease in output (3.04 and 2.44 percentage points in the models with only MGB and LGB respectively).

4. Conclusion

An important challenge facing central banks is the need to understand how the development of financial markets alters the ways in which central banks can affect the economy. In this paper, we considered one aspect of financial development; bank globalization. The results demonstrated that the increasing global scale of banking operations may increase the effectiveness of the Fed by strengthening the BSCMT. The empirical results, obtained using a large bank-level dataset, revealed a larger effect of monetary policy shocks on the leverage sensitivity of MGB. We found that this disparity in the effects of monetary policy on MGB and LGB was quantitatively large by using a Bayesian methodology to estimate a model that is convenient for measuring the BSCMT.

Overall, our results show a positive relationship between bank globalization and the BSCMT. These results, however, do not necessarily suggest a positive relationship between globalization and the strength of monetary transmission. Indeed, there are studies that find that the effect of globalization on the LCMT is negative. Given the results in this paper, the natural next research step is to develop methodologies to compare the strength of these two important channels of monetary transmission and investigate the effects bank globalization on the overall effectiveness of monetary policy.

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Appendix A. The definitions of the variables used in the empirical section

Table A.1

	Acronym	Description
ID	RSSD9001	The primary identifier of a bank.
Date	RSSD9999	The quarter for which the report was filed.
Bank type	RSSD9331	A two-digit code indicating the type of entity. This is used to identify commercial banks
Primary Insurer	RSSD9424	A code indicating the highest level of deposit-related insurance of the head office of a U.S. depository institution or U.S. branch of a foreign bank. This is used to determine whether a bank is
MBHC Affiliation	RSSD9348	The five-digit code assigned to the principle holding company or the highest holding company in a tiered organization.
Large Multi State BHC Affiliation	RSSD9210	A two-digit code assigned to a state of the United States or a U. S. territory in which the entity is physically located or its mailing address.
Total loans	RCFD1400	The aggregate gross book value of total loans (before deduction of valuation reserves)
Capital-Assets Ratio	RCFD3210, RCFD2170	The ratio of total equity capital (RCFD 3210) to the sum of all assets (RCFD 2170).
Liquidity	RCFD0390, RCFD1350, RCFD2146, RCFD0600, RCFD1754, RCFD3545	From 1986Q2 through 1993Q2 period, liquidity is the sum of total investment securities (RCFD0390), RCFD1350, and assets held in trading account (RCFD2146). From 1993Q3 trhough 2009:Q1, liquidity is measured as the sum of RCFD1350, securities held to maturity (RCFD1754), and trading assets (RCFD3545).
Indicators of globalization	BHCK2122	Total loans and leases, net of unearned income.
	BHCK1763	Commercial and industrial loans to U.S. addressees
	BHCK1764	Commercial and industrial loans to non-U.S. addressees
	RSSD9209	The country code of the Foreign Call Family ID
	RSSD9325	The type of foreign ownership of a U.S. chartered entity
	RSSD9329	The percentage of foreign ownership
	RSSD9030	Physical place code
	RSSD9031	Physical country code

Appendix B. The rest of the model and estimation

The Model

The framework is a closed economy standard New Keynesian DSGE model similar to Smets and Wouters (2007). The financial accelerator mechanism of (Bernanke et al., 1999) is embedded into this model to investigate the balance sheet channel of monetary transmission. There are six types of agents in the model: households, entrepreneurs, a domestic bank, retailers, capital producers, and a central bank. Households work, consume, and invest in deposits. Entrepreneurs do not have sufficient internal funds and thus, borrow from domestic banks to finance the production of wholesale goods. The bank uses consumers' deposits to finance entrepreneurs. Retailers transform wholesale goods into final consumption goods. Retailers are monopolistically competitive in order to motivate price stickiness. Capital producers turn investment into capital goods. Finally, a central bank conducts monetary policy using a Taylor (1993) rule. In addition to price stickiness, the model also includes staggered wage setting as a nominal rigidity. We proceed by linearizing the model around its non-stochastic steady state. The resulting system of equations is described below (except for the external finance premium and net worth equations that were explained in Section 3.)

The household's maximization problem produces the following consumption equation:

$$c_t = \frac{\lambda/\gamma}{1+\lambda/\gamma}c_{t-1} + \frac{1}{1+\lambda/\gamma}E_t c_{t+1} + \frac{(1-\lambda/\gamma)}{\sigma(1+\lambda/\gamma)}\left[(\sigma-1)\xi(l_t - E_t l_{t+1}) - (r_t - E_t \pi_{t+!})\right] + \varepsilon_{c,t} \tag{B.1}$$

where c_t is consumption, l_t is labor, r_t is the central bank interest rate, and π_t is the inflation rate. λ is the (external) habit parameter in the household utility function, γ is the steady-state per-capita growth rate of the economy, σ is the inverse of the intertemporal elasticity of substitution, and ξ is a level parameter in the households' utility function which, without loss of generality, will be restricted in the estimation to ensure the steady-state value of labor is equal to 1. $\varepsilon_{c,t}$ is a consumption demand shock which follows an AR(1) process characterized by $\varepsilon_{c,t} = \rho_c \varepsilon_{c,t-1} + \eta_{c,t}$ where ρ_c is the persistence parameter, and $\eta_{c,t}$ is the shock innovation which is distributed *i.i.d.* normal with mean 0 and standard deviation σ_c.[8]

The investment equation is derived from the optimization problem of the capital producers as

$$i_t = \frac{1}{1+\widetilde{\beta}} i_{t-1} + \frac{\widetilde{\beta}}{1+\widetilde{\beta}} E_t i_{t+1} + \frac{1}{\left(1+\widetilde{\beta}\right)\varphi} q_t + \varepsilon_{i,t}, \tag{B.2}$$

where i_t is investment, q_t is the real price of capital relative to the consumption good. $\widetilde{\beta}$ is the adjusted time-discount factor, and is equal to $\beta\eta\gamma^{1-\sigma}$ where β is the simple time-discount factor of households, and η is the population growth rate. φ is an investment adjustment cost parameter, and regulates the elasticity of investment demand with respect to the price of capital.

Output is characterized by the following production function:

$$y_t = \phi_p \left[\varepsilon_{a,t} + \alpha\left(z_t + k_{t-1}\right) + \left(1-\alpha\right) l_t \right], \tag{B.3}$$

where y_t is output, $\varepsilon_{a,t}$ is a productivity shock following an AR(1) process, z_t is the utilization rate of capital, and k_t is the capital stock. The parameter α regulates the share of capital services in production, and ϕ_p is the gross mark-up of home-good prices over marginal cost at the steady-state, which also equals one plus the steady-state share of fixed costs in production.

In equilibrium, the marginal product of capital, mpk_t, is related to the capital-labor ratio and real wages, w_t, as

[8] For brevity, we omit the equations for the rest of the shocks that follow AR(1) processes. We will use ρ for the persistence parameters, and σ for the standard deviation of the innovations of these shocks with appropriate subscripts.

$$mpk_t = -\left(z_t + k_{t-1} - l_t\right) + w_t, \tag{B.4}$$

and capital utilization is related to the marginal product of capital as

$$z_t = \left(\frac{1-\psi}{\psi}\right) mpk_t, \tag{B.5}$$

where ψ is an elasticity parameter related to the cost of changing capital utilization. For example, with $\psi = 1$, the utilization rate stays constant as it is very costly to change it.

The law of motion of capital is given by

$$k_t = \frac{1-\delta}{\eta\gamma} k_{t-1} + \left(1 - \frac{1-\delta}{\eta\gamma}\right)\left[i_t + \left(1+\widetilde{\beta}\right)\varphi\varepsilon_{i,t}\right], \tag{B.6}$$

where δ is the depreciation rate of capital.

Arbitrage requires that the current price of capital is equal to the present value of expected future returns; hence,

$$q_t = \frac{(1-\delta)\tilde{\beta}}{\eta\gamma} E_t q_{t+1} + \left(1 - \frac{(1-\delta)\tilde{\beta}}{\eta\gamma}\right) E_t mpk_{t+1} - E_t r_{k,t+1}. \tag{B.7}$$

The retailers' problem yields a partially forward-looking New Keynesian Phillips curve for home-goods price inflation:

$$\pi_t = \frac{\iota_h}{1+\iota_h\widetilde{\beta}}\pi_{t-1} + \frac{\widetilde{\beta}}{1+\iota_h\widetilde{\beta}} E_t\pi_{t+1} - \frac{\left(1-\xi_h\right)\left(1-\xi_h\widetilde{\beta}\right)}{3.5\xi_h\left(1+\iota_h\widetilde{\beta}\right)}\left[\varepsilon_{a,t} + \alpha\left(z_t + k_{t-1} - l_t\right) - w_t\right] + \varepsilon_{h,t}, \tag{B.8}$$

where $\pi_t = p_t - p_{t-1}$ is the inflation rate, and $\varepsilon_{h,t}$ is a cost-push shock which follows an ARMA(1,1) process given by $\varepsilon_{h,t} = \rho_h\varepsilon_{h,t-1} + \eta_{h,t} - \mu_h\eta_{h,t-1}$. The parameter ι_h determines the degree to which prices are indexed to past domestic price inflation, and ξ_h is the probability that firms cannot adjust their prices in any given period.[9] The above Phillips curve ties current home-good inflation rate to past and expected future inflation as well as the marginal cost (i.e. the difference between the real wage and the marginal product of labor) of firms.

The relationship between nominal wage inflation, $\pi_{w,t}$, consumer price inflation and real wages can be expressed as

$$\pi_{w,t} = w_t - w_{t-1} + \pi_t \,. \tag{B.9}$$

Staggered wage-setting by households yields the following wage inflation Phillips curve:

$$\pi_{w,t} - \iota_w \pi_{t-1} = \tilde{\beta}\left(E_t \pi_{w,t+1} - \iota_w \pi_t\right) - \frac{\left(1-\xi_w\right)\left(1-\xi_w \tilde{\beta}\right)}{6\xi_w}\left\{w_t - \left[\sigma_l l_t + \frac{1}{1-\lambda/\gamma}\left(c_t - \frac{\lambda}{\gamma}c_{t-1}\right)\right]\right\} + \varepsilon_{w,t}\,, \tag{B.10}$$

where $\varepsilon_{w,t}$ is a cost-push shock following an ARMA(1,1) process $\varepsilon_{w,t} = \rho_w \varepsilon_{w,t-1} + \eta_{w,t} - \mu_w \eta_{w,t-1}$. ι_w is the parameter determining the degree of inflation indexation of nominal wage inflation, σ_l is the inverse of the elasticity of labor supply, and ξ_w is the probability that households cannot adjust their wages in any given period. The wage Phillips curve ties current wage inflation to the difference between real wages and the marginal rate of substitution between consumption and leisure, as well as past and present price inflation, and expected future wages.

Monetary policy is conducted via a Taylor rule for the nominal interest rate:

$$r_t = \rho r_{t-1} + (1-\rho)[r_\pi \pi_t + r_y y_t + r_{\Delta y}\left(y_t - y_{t-1}\right)] + \varepsilon_{r,t}\,, \tag{B.11}$$

where ρ is the interest-rate smoothing parameter, r_π, r_y and $r_{\Delta y}$ are the long-run response coefficients of the central bank to inflation, output, and output growth respectively, and $\varepsilon_{r,t}$ is an exogenous AR(1) process capturing shocks to monetary policy.

Finally, the feasibility condition for the economy is given by

[9] The 3.5 term in the denominator comes from the Kimball aggregator function used by final goods producers at the calibrated values in Smets and Wouters (2007).

$$y_t = \frac{C}{Y} c_{h,t} + \frac{I}{Y} i_{h,t} + \frac{G}{Y} \varepsilon_{g,t} , \tag{B.12}$$

where $\varepsilon_{g,t}$ captures government expenditure (and net exports), and is determined by an exogenous AR(1) process.[10]

Data, calibrated parameters and prior estimates

We estimate the model parameters using Bayesian likelihood methods.[11] The model includes 7 shocks that are commonly used in the literature (c.f. Smets and Wouters, 2007). These are: 3 demand shocks (consumption, investment and government expenditure), 1 productivity shock, 1 monetary shock, 2 cost-push shocks (price and wage). Our model includes 3 additional financial shocks: shock to the external premium of MGB and LGB borrowers and a net worth shock. We assume that the net worth shock is common to both types of borrowers.

Following Gilchrist et al. (2009), we shut down the investment shocks since these present an identification problem for the role of financial shocks. To estimate the parameters, we use 11 quarterly data series from the U.S. for the period 1986Q2 to 2009Q1. To identify the external finance premiums of the two types of borrowers we use the average total loans of MGB and LGB in our dataset. These variables ($b_{1t} = q_{1t} + k_{1t} - n_{1t}$, $b_{2t} = q_{2t} + k_{2t} - n_{2t}$) are measured as simple averages and are deflated using the GDP deflator. The real GDP, real personal consumption expenditures, real private fixed investment, real government consumption expenditures and gross investment are obtained the Bureau of Economic Analysis. The average weekly hours and the hourly compensation for nonfarm businesses come from the Bureau of Labor Statistics (the average hours are multiplied with the Civilian Employment). Inflation rate

[10] Note that technically, the feasibility condition of the model should also include the consumption of entrepreneurs who do not survive the period, real costs incurred due to the utilization of capital, and costs of financial intermediation. We ignore these components since they are small.

[11] The use of Bayesian priors have become commonplace in the literature due to the scarcity of macroeconomic data and identification\n problems. See An and Schorfheide (2007) and Fernandez-Villaverde (2009) for more on Bayesian estimation of DSGE models. We use *Dynare* to estimate and simulate our model.

is the first difference of the log of the GDP deflator and the interest rate is the gross Fed funds rate. The net worth of entrepreneurs is identified by the value of the stock market (S&P 500) index as in Christiano et al. (2009). All data series are seasonally adjusted, first-differenced (except the inflation rate and the nominal interest rate), and demeaned prior to estimation.[12]

Since the data used in the estimation do not contain information about parameters that determine the first moments of model variables, we calibrated some of the level parameters prior to estimation to get more reasonable steady-states (Smets and Wouters, 2007, and Alpanda, 2009). These parameters are listed in Table B.1.

The population growth factor, η, and the per-capita growth of output, γ, are set to 1.0025 and 1.005 implying (near) 1% population growth and 2% output growth on an annual basis. The adjusted time-discount factor, $\widetilde{\beta}$ is set to 0.99 which implies a (near) 4% annualized real interest rate (i.e. risk-free rate) along the balanced growth path of the model.[13] We set the capital share parameter in the production function, α, to 0.3 which implies a steady-state share of labor income of 70%. The depreciation rate of capital, δ, is set to 0.025 which implies a (near) 10% annual depreciation rate. Following Gilchrist et al. (2009), the survival probability of entrepreneurs, γ_e, is set to 0.99. We set the share of lending by MGB, ς to the average of MGB' lending to total lending throughout the sample period (0.37). The elasticity of substitution parameter, ρ is set equal to 1.[14]

The prior distributions and the posterior estimates of the parameters are reported in Tables B.2 and B.3. The prior distributions are similar to Smets and Wouters (2007) and Gilchrist et al. (2009).

[12] We specify another set of variables in the model which are consistent with the first-differenced observed variables.
[13] Note that we do not need to set a value for the actual time-discount factor, β, which is related to the adjusted factor with $\widetilde{\beta} = \beta\eta\gamma^{1-\sigma}$, since β does not enter any of the log-linearized conditions by itself.
[14] Calibrating this parameter considerably simplified the estimation. Using different values however, produced similar results.

Table B.1 Calibrated Parameters

Parameters	Description	Value
β	time discount parameter	0.99
η	population growth rate	1.0025
γ	per-capita growth rate	1.005
α	share of capital	0.3
δ	capital depreciation	0.025
γ_e	survival probability of entrepreneurs	0.99
ς	aggregate output -- share parameter (MGB)	0.37
p	aggregate output -- elasticity of substitution	1

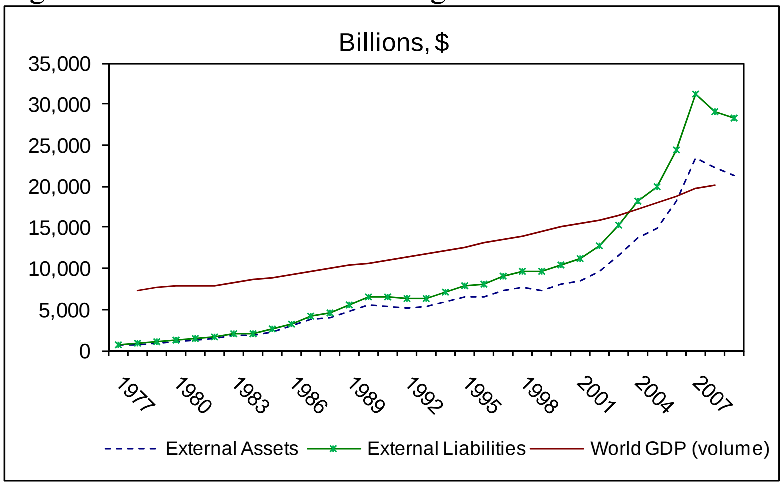
Table B.2 Prior Distributions and Posterior estimates of structural parameters

		Prior Distributions			Posterior Distrib.-Benchmark		Posterior Distrib.-Global		Posterior Distrib.-Domestic	
Param.	Description	Distrib.	Mean	std. dev	Mean	std. dev	Mean	std. dev	Mean	std. dev
λ	External habit	B	0.7	0.200	0.979	0.003	0.984	0.002	0.9751	0.005
σ	inverse intertemp. elasticity of subs.	N	1.5	0.370	0.860	0.059	0.816	0.036	0.8371	0.084
φ	investment adjustment cost	N	4	1.500	8.393	0.706	8.354	0.874	8.628	0.812
ϕ_p	price mark-up	N	1.25	0.200	2.259	0.081	2.166	0.101	2.1427	0.102
ϕ_w	wage mark-up	N	1.5	0.100	1.492	0.083	1.534	0.315	1.4676	0.085
ψ	capital utilization elasticity param.	B	0.5	0.200	0.109	0.040	0.038	0.017	0.0593	0.033
χ_1	leverage elasticity of risk premium -- global	B	0.07	0.020	0.174	0.013	0.166	0.004		
χ_2	leverage elasticity of risk premium -- domestic	B	0.07	0.020	0.066	0.018			0.0565	0.010
ι_h	price indexation	B	0.5	0.150	0.229	0.068	0.189	0.057	0.3326	0.080
ξ_h	probability of keeping prices constant	B	0.5	0.100	0.196	0.040	0.214	0.041	0.2214	0.055
ι_w	wage indexation	B	0.5	0.150	0.639	0.075	0.419	0.082	0.3667	0.097
σ_l	inverse labor supply elasticity	N	2	0.750	0.084	0.587	0.757	0.791	0.182	0.684
ξ_w	probability of keeping wages constant	B	0.5	0.100	0.639	0.023	0.664	0.020	0.6422	0.045
ρ	Taylor rule -- interest rate smoothing	N	0.75	0.100	0.960	0.004	0.963	0.004	0.9546	0.005
r_π	Taylor rule -- inflation	N	1.5	0.120	1.191	0.077	1.250	0.088	1.18	0.089
r_y	Taylor rule -- output	N	0.12	0.050	0.194	0.042	0.210	0.037	0.2006	0.046
$r_{\Delta y}$	Taylor rule -- output growth	N	0.12	0.050	0.156	0.045	0.106	0.050	0.137	0.041

Table B.3 Prior Distributions and Posterior estimates of shock parameters

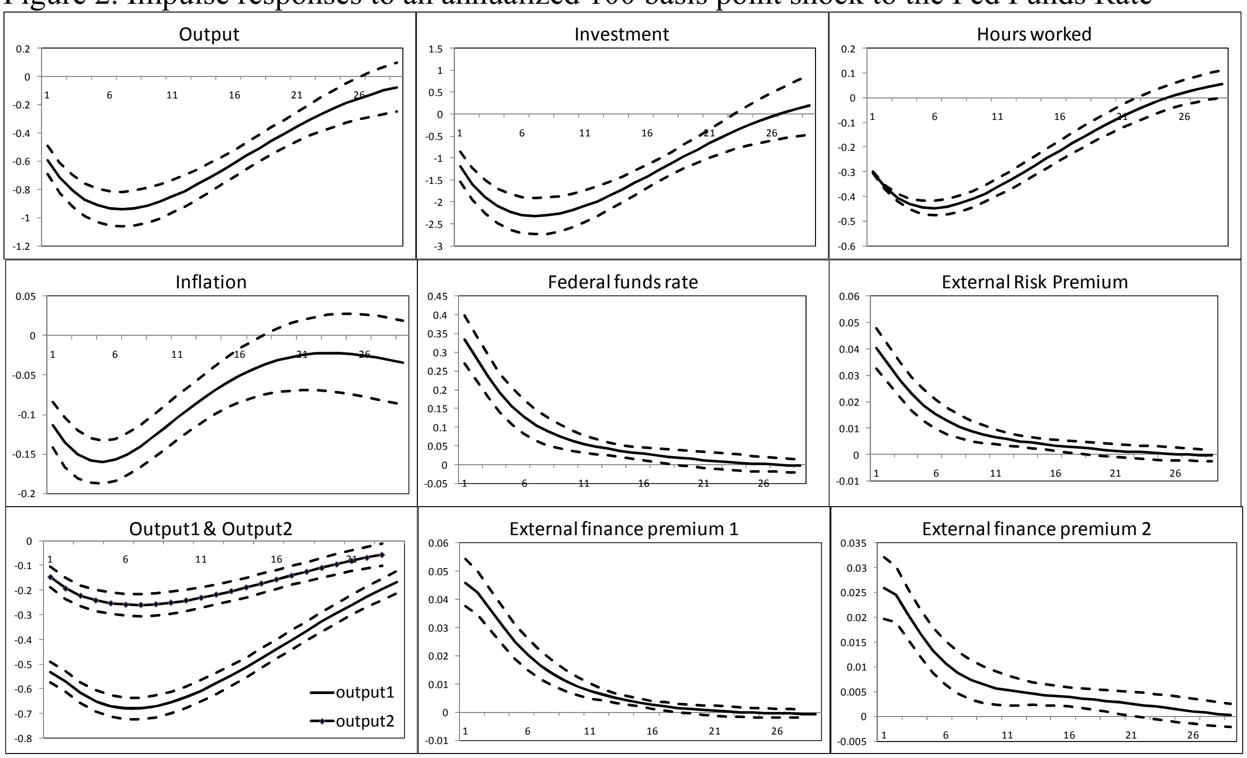
		Prior Distributions			Posterior Distrib.-Benchmark		Posterior Distrib.-Global		Posterior Distrib.-Domestic	
Param.	Description	Distrib.	Mean	std. dev	Mean	std. dev	Mean	std. dev	Mean	std. dev
Persistence										
ρ_c	consumption shock	B	0.5	0.200	0.094	0.002	0.123	0.044	0.113	0.056
ρ_h	price shock	B	0.5	0.200	0.509	0.180	0.442	0.163	0.472	0.208
ρ_w	wage shock	B	0.5	0.200	0.844	0.033	0.846	0.029	0.797	0.049
ρ_i	investment shock	B	0.5	0.200	0.660	0.056	0.703	0.053	0.628	0.041
ρ_g	government spending shock	B	0.5	0.200	0.977	0.004	0.981	0.001	0.983	0.003
ρ_r	interest rate shock	B	0.5	0.200	0.130	0.040	0.107	0.037	0.147	0.044
ρ_a	technology shock	B	0.5	0.200	0.910	0.036	0.888	0.049	0.901	0.036
ρ_{k1}	risk premium shock -- global	B	0.5	0.200	0.720	0.105	0.618	0.196		
ρ_{k2}	risk premium shock -- domestic	B	0.5	0.200	0.722	0.101			0.503	0.198
ρ_n	net worth shock	B	0.5	0.200	0.077	0.033	0.050	0.017	0.113	0.049
Standard deviation										
σ_c	consumption shock	IG	0.005	inf	0.0028	0.0002	0.0027	0.0003	0.0027	0.0002
σ_h	price shock	IG	0.005	inf	0.0037	0.0012	0.0027	0.0009	0.0048	0.0019
σ_w	wage shock	IG	0.005	inf	0.0041	0.0008	0.0041	0.0008	0.0052	0.0008
σ_i	investment shock	IG	0.005	inf	0.0052	0.0006	0.0051	0.0005	0.0057	0.0007
σ_g	government spending shock	IG	0.005	inf	0.0268	0.0018	0.0254	0.0010	0.0268	0.0017
σ_r	interest rate shock	IG	0.005	inf	0.0025	0.0001	0.0028	0.0001	0.0026	0.0002
σ_a	technology shock	IG	0.005	inf	0.0024	0.0002	0.0025	0.0002	0.0023	0.0002
σ_{k1}	risk premium shock -- global	IG	0.005	inf	0.0083	0.0028	0.0034	0.0011		
σ_{k2}	risk premium shock -- domestic	IG	0.005	inf	0.0071	0.0017			0.0035	0.0016
σ_n	net worth shock	IG	0.005	inf	0.0763	0.0037	0.1023	0.0063	0.0531	0.0028

Figure 1. Globalization of banking



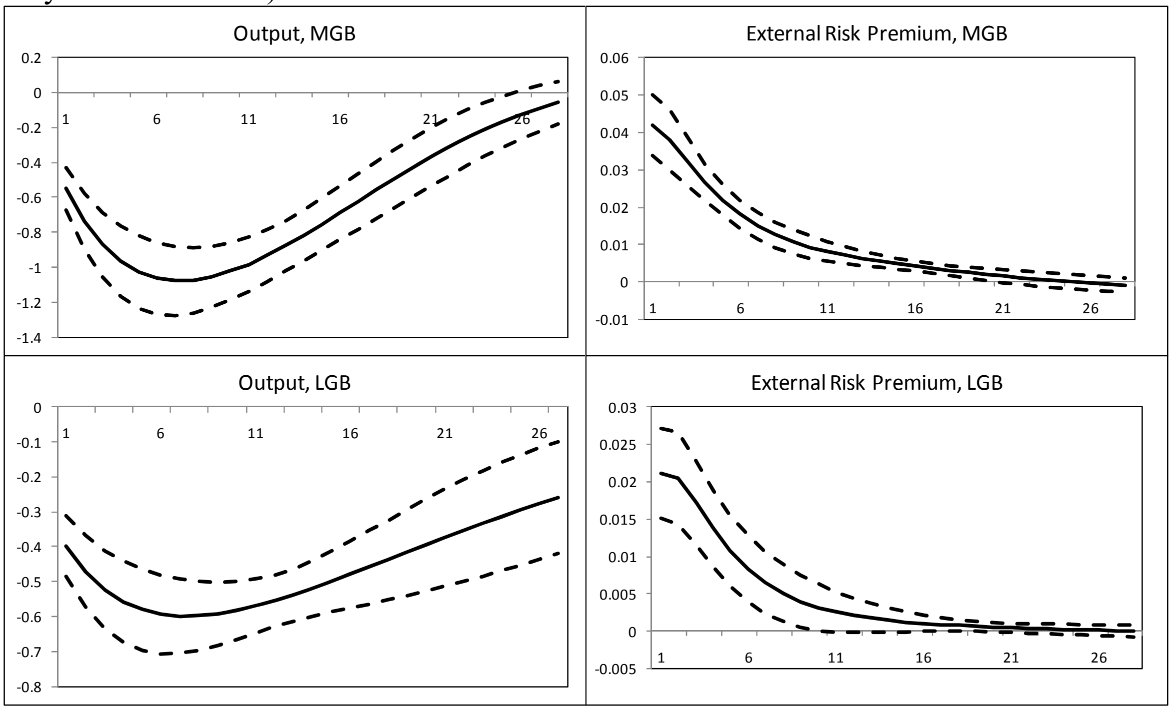
Note: The data for the external assets and liabilities of banks were obtained from the BIS and the World GDP volume is from the International Financial Statistics (IFS). The external assets and liabilities are converted to real dollars and the world GDP volume is an index measure.

Figure 2. Impulse responses to an annualized 100 basis point shock to the Fed Funds Rate



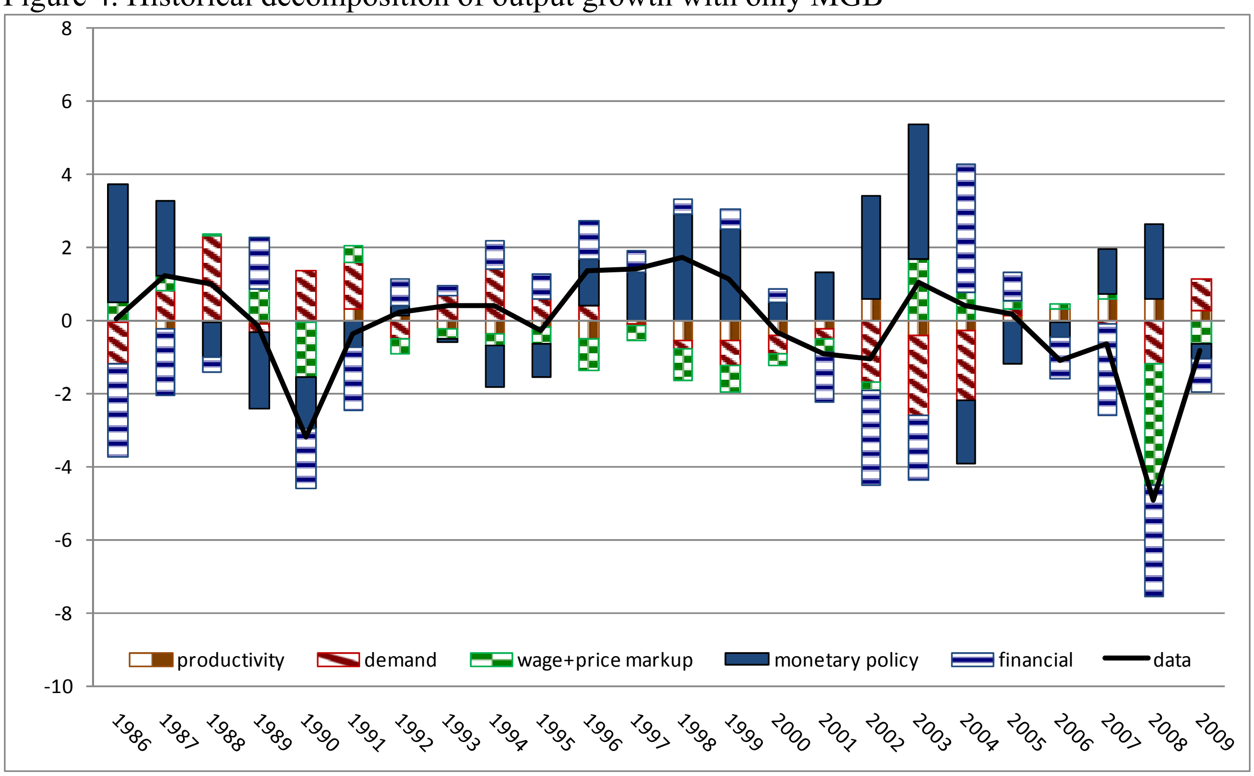
Note: The figure displays the estimated impulse responses in the model with both MGB and LGB. The dotted lines denote the 90 percent confidence intervals.

Figure 3. Impulse responses to an annualized 100 basis point shock to the Fed Funds rate (with only MGB and LGB)



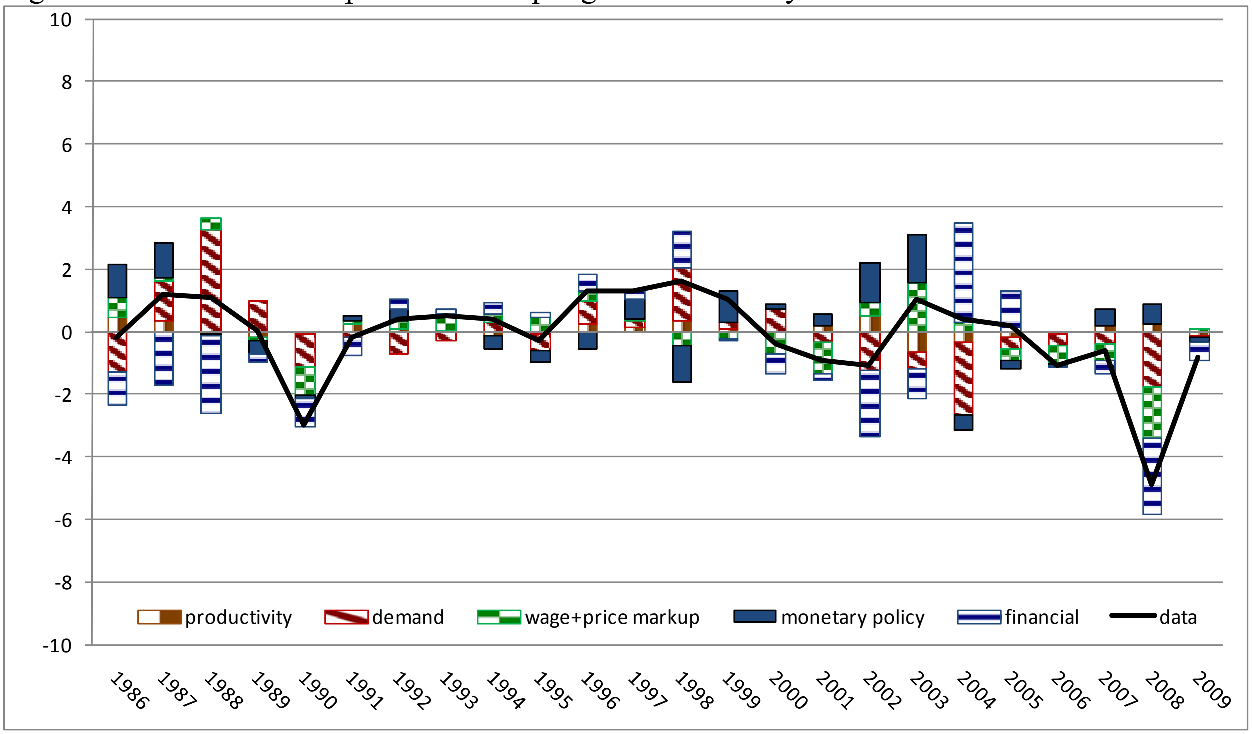
Note: The figure displays the estimated impulse responses in the models with only MGB and LGB. The top (bottom) two graphs display the impulse responses from the model with only MGB (LGB). The dotted lines denote the 90 percent confidence intervals.

Figure 4. Historical decomposition of output growth with only MGB



Note: The stacked bars show the historical contribution of various shocks to annual per capita, real GDP growth in the model with only MGB. The solid line is the growth rate of real GDP per capita.

Figure 5. Historical decomposition of output growth with only LGB



Note: The stacked bars show the historical contribution of various shocks to annual per capita, real GDP growth in the model with only LGB. The solid line is the growth rate of real GDP per capita.

Table 1. Descriptive Statistics

period	number of banks: total	number of banks: sample	MGB: number	MGB: size	MGB: avg. number of affiliates	LGB: number	LGB: size	LGB: avg. number of affiliates
1986	15,750	9,527	181	5,834	12.6	1,026	1,232	10.8
1987	15,448	9,699	189	8,304	12.0	1,069	1,775	10.7
1988	14,909	9,531	175	8,490	10.5	1,162	2,031	10.4
1989	14,354	9,319	166	8,922	8.8	1,165	2,197	9.5
1990	13,959	9,127	227	11,550	7.3	1,233	3,012	8.7
1991	13,581	8,965	216	10,942	6.7	1,282	3,752	8.3
1992	13,136	8,679	212	11,296	5.7	1,388	3,858	8.8
1993	12,714	8,387	187	12,137	7.7	1,434	4,192	7.8
1994	12,190	8,144	183	13,533	7.6	1,178	4,522	7.3
1995	11,591	7,857	176	14,417	6.3	1,209	5,093	6.9
1996	11,186	7,736	168	15,545	7.1	1,281	4,929	6.0
1997	10,797	7,558	179	17,302	7.0	1,347	5,021	5.2
1998	10,325	7,315	154	19,642	6.1	1,451	5,455	5.7
1999	9,956	7,177	155	24,128	6.5	1,479	6,240	5.5
2000	9,656	6,984	148	29,149	5.6	1,520	6,319	5.1
2001	9,302	6,790	147	30,014	5.6	1,619	7,394	4.7
2002	8,998	6,620	131	33,071	5.3	1,744	8,775	4.6
2003	8,822	6,595	162	39,248	5.7	1,957	9,305	4.3
2004	8,665	6,514	167	47,535	4.8	2,133	10,149	4.7
2005	8,543	6,463	175	54,750	4.7	2,184	10,698	4.5
2006	8,498	6,412	117	39,220	4.7	897	8,584	4.4
2007	8,352	6,351	116	44,869	5.0	878	7,233	4.4
2008	8,119	6,221	114	48,549	5.3	870	8,065	4.2
2009	8,061	6,183	119	55,539	4.1	921	8,132	4.6

Notes: 1. The table reports the number of banks and BHCs, and the size and number of affiliates of BHCs in our sample.
2. More global and less global BHCs are denoted by MGB and LGB respectively.
3. The number of banks and BHCs denote the total number of different banks and BHCs in a given year. These numbers *are not* the sum of the quarterly observations in a given year.
4. The size variable is total assets measured in millions. Both the size and the number of variables are measures as simple averages in a given year.

Table 2. The effect of monetary policy on balance sheet sensitivity, MGB versus LGB

	Whole Sample: Real FFR	Whole Sample: Nominal FFR	MGB: Real FFR	MGB: Nominal FFR	LGB: Real FFR	LGB: Nominal FFR
Accounting for the Generated	-0.09	-0.08	-0.29	-0.52	-0.02	0.02
Regressors problem	(0.88)	(1.91)*	(8.81)***	(10.86)***	(0.58)	(0.560)
Not Accounting for the Generated	-0.13	-0.09	-0.22	-0.24	-0.11	0.08
Regressors problem	(1.35)	(1.65)	(4.10)***	(2.44)**	(1.32)	(1.08)
Number of observations	92	92	92	92	92	92

NOTES: 1. This table displays the results from the estimation of the second stage equation (equation 2). The reported coefficient values represent the aggregate effect of monetary policy on balance sheet sensitivity.
2. The numbers in the parenthesis are the *F-statistics* used to test the joint significance of the monetary policy coefficients. * significant at 10%; ** significant at 5%; *** significant at 1%. *F-statistics* have been corrected for heteroskedasticity and autocorrelation.
3. The balance sheet sensitivity coefficients are estimated separately for more global and less global BHCs in the first stage. The results of the second stage regressions for these two groups are reported in the columns MGB and LGB.
4. The top panel accounts for the generated regressors problem by including the standard errors of the dependent variables that were measured in the first stage regressions. The bottom panel does not account for the generated regressors problem.
5. Real and nominal Fed Funds rates (FFR) are used to measure the stance of monetary policy.

Table 3. Robustness

		Real FFR	Nominal FFR	BB	CE	S	Borrowed R.	BM
Benchmark	MGB	-0.29	-0.52	-5.37	-2.26	-2.44	-1.64	-1.77
		(8.81)***	(10.86)***	(18.02)***	(23.86)***	(13.93)***	(20.95)***	18.26)**
	LGB	-0.02	0.02	-0.49	-0.13	0.16	-0.10	-0.36
		(0.58)	(0.560)	(5.51)***	(2.55)***	(3.00)***	(2.77)***	(2.65)**
Accounting for Size	MGB	-0.29	-0.52	-5.37	-2.26	-2.44	-1.64	-1.77
		(8.81)***	(10.86)***	(18.02)***	(23.86)***	(13.93)***	(20.95)***	18.26)**
	LGB	-0.03	-0.11	-0.58	-0.34	0.12	-0.23	-1.34
		(0.79)	(1.34)	(2.94)***	(1.97)*	(1.74)	(2.65)**	(1.86)*
Degree of globalization	G1	-0.77	-0.56	-3.90	-0.25	-1.42	-0.19	-0.15
		(3.60)***	(2.53)**	(2.91)***	(2.06)**	(1.88)*	(1.80)*	(1.48)
	G2	-0.04	-0.01	-0.98	-0.05	-0.15	-0.08	-1.17
		(0.66)	(1.42)	(8.11)***	(7.51)***	(10.25)***	(9.72)***	(7.05)***
Excluding crisis periods	MGB	-0.30	-0.58	-6.60	-2.12	-5.45	-1.52	-0.87
		(8.36)***	(11.38)***	(14.17)***	(20.51)***	(27.51)***	(18.91)***	17.31)**
	LGB	0.01	0.01	-0.47	-0.14	-0.15	-0.10	-0.44
		(0.93)	(0.36)	(3.55)***	(2.38)**	(2.77)***	(2.34)**	(2.81)***
	LGB-size	-0.05	-0.10	-0.85	-0.03	-0.08	-0.18	-0.34
		(1.21)	(2.10)**	(5.10)***	(3.99)***	(9.63)***	(3.92)***	11.31)**
Subperiod 1994-2009	MGB	1.50	-0.15	-15.40	-1.01	-2.46	-0.76	-3.23
		(15.49)***	(17.24)***	(19.01)***	(8.88)***	(11.74)***	(7.89)***	12.12)**
	LGB	-0.18	-0.13	-5.23	-0.33	-0.11	-0.32	-0.63
		(6.42)***	(4.58)***	(7.16)***	(1.84)*	(1.73)	(2.49)**	(4.05)***
Subperiod 1978-1993	MGB	-0.06	0.03	-27.43	-0.21	-0.81	-0.16	-0.28
		(3.15)***	(1.44)	(1.72)	(1.80)*	(1.62)	(1.93)*	(2.06)*
	LGB	-0.05	0.04	-8.58	-0.39	-0.56	-0.09	-0.46
		(2.71)**	(2.67)**	(4.30)***	(5.44)***	(4.22)***	(5.16)***	(3.45)***

NOTES: 1. This table displays the results from the estimation of the second stage equation (equation 2). The reported coefficient values represent the aggregate effect of monetary policy on balance sheet sensitivity.
2. The numbers in the parenthesis are the *F-statistics* used to test the joint significance of the monetary policy coefficients. * significant at 10%; ** significant at 5%; *** significant at 1%. *F-statistics* have been corrected for heteroskedasticity and autocorrelation.
3. In the second stage regressions the generated regressors problem is accounted for.
4. The measures for monetary policy stance are: the real and nominal Fed Funds rate (FFR), Bernanke and Blinder (1992) index (BB), Christiano and Eichenbaum (1992) index, Strongin (1995) index, index constructed using the variation in borrowed reserves, and the Bernanke and Mihov (1998) index.