Switching Costs for Bank-Dependent Borrowers and the Bank Lending Channel of Monetary Policy

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Abstract

In this paper we study the relationship between switching costs for bank-dependent borrowers and the effectiveness of monetary policy through the bank lending channel. Our contribution to the literature is two-fold. First, we apply the model of Kim, Kliger and Vale (2003) to provide structural estimates of switching costs in the market for bank credit in the United States. We find that switching costs have followed a downward trend until 2001, and have started rising again since then. Second, we show that these costs have an important effect on the environment in which monetary policy is conducted, and that this effect is independent from that of financial constraints of the banking industry itself. Specifically, the higher switching costs, the larger the impact of monetary policy shocks on the real sector.

Our work uncovers policy implications particularly relevant at a time when monetary policy is being heavily used to address recessions around the world, while the financial crisis is leading to significant market structure changes in banking, which in turn can impact the magnitude of the switching costs we study here.

Keywords: switching costs, banking, lending channel, monetary policy. JEL codes: E4, E5.

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1 Introduction

In this paper we study the relationship between switching costs for bank-dependent borrowers and the effectiveness of monetary policy. We focus on the bank lending channel, according to which the banking sector is specially relevant to the transmission mechanism of monetary shocks[1].

The gist of the bank lending channel is that after a monetary policy contraction, banks are forced to cut back their loan supply, which negatively impacts employment, investment and production (see Bernanke and Blinder (1988), Kashyap, Stein, and Wilcox (1993), Bernanke and Gertler (1995), and Kashyap and Stein (1994, 1995 and 2000), among others). This channel of monetary policy transmission works on the supply-side of the market for loans, and amplifies the traditional demand-side interest rate channel[2]. Two conditions are necessary for this channel to be operative. First, after a monetary tightening banks must lack the ability to costlessly resort to non-deposit funding to offset the reduction in reserves and access to loanable funds induced by this policy, and they must therefore be forced to reduce their credit supply[3]. Second, bank-dependent firms cannot costlessly

[1]The switching costs that we study are those arising from informational asymmetries between borrowers and lenders on the former's creditworthiness, that allow incumbent banks to accumulate information over time, and to eventually earn an informational monopoly over their customers. This creates a "lock-in" effect that makes it costly for firms to switch lenders. A recent body of empirical work documents the importance of switching costs for borrowers. Hubbard, Kuttner and Palia (2002), Shy (2002), Kim, Kliger and Vale (2003) empirically document the importance of switching costs in the banking industry. Santos and Winton (2008) use micro loan data and find that bank-dependent firms without accessibility to public debt markets pay significantly higher loan rates, implying that banks take advantage of their information monopoly. Last, Hale and Santos (2008) show that firms are able to borrow from banks at lower interest rates after they issue for the first time in the public bond market, and they interpret this finding as evidence that banks do indeed price their informational monopoly.

[2]It has been shown empirically that monetary policy has a considerably larger impact on the economy than what it would have through only the interest rate mechanism (see Bernanke and Gertler (1995)). Thus, the effects of monetary policy cannot be fully explained by the traditional interest rate channel, which suggests that there is room for additional transmission mechanisms of monetary policy. A large body of literature uses cross-sectional bank-level data and establishes that the bank lending channel is at work (see Bernanke and Blinder (1992), Kashyap, Stein, and Wilcox (1993), Kashyap and Stein (1995 and 2000), Stein (1998), Favero, Giavazzi and Flabbi (1999), Kishan and Opiela (2000) and Alfaro et al (2003), among others).

[3]Based on this first condition, the effectiveness of the bank lending channel is also a function of the institutional characteristics and in particular, of the financial strength of the banking industry. The intuition is that lending by smaller, less liquid and/or less capitalized banks is more sensitive to a reduction in reserves than that of their larger, stronger counterparts. We explore this dependence on individual bank characteristics in Section 3.

switch to alternative sources of finance as the cost of bank credit rises.

This second condition unveils the importance of studying the relationship between borrowers costs of switching banks and the effectiveness of monetary policy through the bank lending channel. Based on this condition, whether monetary policy has significant effects on economic activity depends on the magnitude of these switching costs.

Back in the late 1990's Stein (1998) concluded his work by pointing to the lack of knowledge on how switching costs impact monetary policy as an important limitation of the literature at the time. Stein (1998) argues: "But even if it can be concluded that banks cut their loans sharply as a result of the mechanism modeled above (...a monetary tightening), one still needs to know how readily their customers can switch to nonbank forms of finance. Absent a measure of this elasticity of substitution, the micro data on banks cannot speak to the ultimate investment or output consequences of monetary policy. Clearly, this remains a challenging topic for future work". Unfortunately, ten years later the literature still presents this limitation and, to our knowledge, there is no empirical work that assesses this impact[4]. One main reason for this gap in the literature is that switching costs are unobservable, and even data on borrowers switching behavior are hard to find. Thus, switching costs need to be estimated by the researcher.

Our goal in this paper is to start addressing this limitation of existing work, by studying the relationship between switching costs and the effectiveness of monetary policy. As a by-product, we contribute to the literature by providing estimates of switching costs in the market for bank credit in the United States.

We proceed in two steps. First, we structurally estimate the model of Kim, Kliger and Vale (2003), and obtain estimates of switching costs for bank-dependent borrowers in the U.S.. We do so using bank-level balance sheet and income statement data for commercial banks in the U.S. from the Call Reports on Condition and Income. Second, we use these estimates to study the impact of

[4]van den Heuvel (2007) argues that in the absence of switching costs and with any financially unconstrained banks, idiosyncratic fluctuations in lending by those banks negatively impacted by monetary policy would be completely "picked up" by other unconstrained/healthier banks. Thus, monetary policy would cease to have effects in the absence of switching costs. He also argues that when switching costs exist, part of the idiosyncratic fluctuations in bank lending will result in changes in aggregate credit and aggregate real effects on the economy. Furthermore, the share of fluctuations that translates into changes in aggregate credit should be increasing in the magnitude of the switching costs.

switching costs on the real effects of monetary policy through the bank lending channel. Here we exploit the bank-level nature of these data to identify the supply-side effects of monetary policy, to isolate the effect of switching costs from that of other banks' characteristics that proxy for their financial constraints, and to assess the robustness of our results across heterogeneous banks.

The intuition behind the hypothesis that switching costs can have an impact on the effectiveness of monetary policy through the bank lending channel is the following: After a monetary policy tightening, small banks (who are typically more severely affected by the tightening) shrink their loan supply. If borrowers cannot costlessly switch among lenders, the excess demand left by these small banks cannot be picked up by larger banks (who can better protect their loan supply). Therefore, our hypothesis is that at the aggregate level, the response of the total supply of credit to a change in monetary conditions should be increasing in the magnitude of these switching costs.

Our paper is related to the empirical literature that studies the implications of market structure in banking for the transmission of monetary shocks. Cottarelli and Kourelis (1994) show for a cross-section of countries that the structure of financial markets affects the degree of adjustment of lending rates to money market rates, especially in the short run. Adams and Amel (2005) provide evidence that increased market concentration in banking tends to weaken the effects of monetary policy through the bank lending channel. Olivero, Li and Jeon (2011a and 2011b) use bank-level data for a wide sample of Asian and Latin American countries and show that increased competition in banking lowers the sensitivity of bank lending to monetary shocks. Our paper is also related to the theoretical work in this field. Peltzman (1969) develops a model to test the effect of banking market structure on monetary policy transmission. He suggests that markets dominated by small banks respond faster to monetary policy than those dominated by large banks due to the difference in information costs between large and small banks. Vanhoose (1985) investigates the impact of financial market structure on a central bank's ability to control monetary aggregates. Under the assumption of Cournot competition among financial institutions, market structure may affect a central bank's ability to control monetary aggregates and its choice of policy instrument. Blei (2004) develops a model to show that credit market structure affects the intensity of monetary policy transmission. Ghossoub, Laosuthi and Reed (2006) develop a general equilibrium model to show that with a less competitive banking system monetary policy can affect credit market activities more significantly.

Our results show that switching costs have an important effect on the environment in which monetary policy is conducted. Specifically, our results show that the presence of switching costs strengthens the bank lending channel of monetary transmission. Furthermore, this effect is independent from that of financial constraints of the banking industry itself, as measured by banks' size and degree of liquidity and capitalization in their balance sheets.

Interesting policy implications arise from these results. Specifically, when the supply of bank loans shrinks after a monetary tightening, smaller firms with less access to other forms of funding (i.e. those firms typically subject to higher switching costs) bear most of the costs of monetary policy. Therefore, when working through the bank lending channel, monetary policy exerts asymmetric effects on borrowers of heterogeneous size. Given that small firms contribute to more than 50% of total jobs in the private sector in the U.S., this asymmetric distribution of costs is important from a policy perspective. Therefore, if switching costs do indeed amplify the impact of the bank lending channel, then monetary tightenings could be accompanied by prudential regulation efforts aimed at lowering switching costs to compensate small borrowers for their asymmetric bearing of the costs of policy.

The paper proceeds as follows. In Section 2 we present the structural estimation of switching costs. In Section 3 we present the methodology used to study the relationship between these costs and the bank lending channel. In Section 4 we provide the estimation results. In Section 5 we conclude.

2 Switching Costs Estimation

In this section we estimate switching costs following Kim, Kliger and Vale (2003) (hereafter KKV), the only method available to estimate these costs based on bank-level data even when switching decisions are not observable. The key assumption in KKV is that changes in a firm's market share imply costumer switching. Based on this assumption switching costs can be recovered using the evolution of firms market shares arising from the endogenous behavior of banks and borrowers in the model.

In what follows we only present the main features of the model and the equations we estimate. We refer the reader to KKV for more details and complete derivations of their model.

2.1 The Model

Consider an economy where in every period t, n banks compete nation-wide in the interest rate they charge on loans. Given the interest rates charged by the banks, each customer optimally chooses which bank to borrow a fixed amount from. Both banks and borrowers know that switching banks is costly and the switching costs are known to both of them. This customer behavior yields probabilities of switching between any two banks, which are labeled *transition probabilities*. Therefore, the demand for loans faced by each bank is determined by the aggregation of these transition probabilities.

2.1.1 Demand

In what follows let $p_{i,t}$ denote the interest rate charged by bank i in period t, and let a $(n-1)$ vector $\mathbf{p}_{iR,t}$ denote the interest rates charged by bank i's rivals. The jth element of $p_{iR,t}$ is the interest rate charged by bank j. The borrower will bear switching costs if she switches to a bank from which she did not borrow in the last period. These switching costs are denoted by s.

The probability of borrowing from a specific bank can be approximated by the proportion of borrowers who borrow from that bank. Thus, let $\Pr_{i\to i,t}$ denote the transition probability that a firm that borrowed from bank i in period $t-1$ continues to borrow from the same bank in the subsequent period. This probability is determined by the interest rates charged by bank i and by her $n-1$ rivals, and given by:

$$\Pr_{i\to i,t} = f\{p_{i,t}, \mathbf{p}_{iR,t} + \mathbf{s}\} \tag{1}$$

where $\mathbf{s}$ is an $(n-1)$ vector in which each element equals the switching costs s.

Similarly, $\Pr_{j\to i,t}$ denotes the probability that a borrower who borrowed from bank j in the previous period switches to borrow from bank i in period t. It is given by:

$$\Pr_{j\to i,t} = f\{p_{i,t} + s, \mathbf{p}_{iR,t} + \mathbf{s}_j\} \tag{2}$$

Where $\mathbf{s}_j$ is an $(n-1)$ vector in which each element equals s, except the jth element, which is zero. Since the individual switching behavior is unobserved, the transition probability function needs to be defined as unconditional on the identities of bank i's rivals.

Following the derivations in KKV(2003), it can be shown that bank i's market share follows the law of motion given by:

$$\sigma_{i,t} = -\sigma_{i,t-1}\frac{n}{n-1}s\alpha_1 + \alpha_0^i + \alpha_1\left(p_{i,t} - \overline{p}_{iR,t} + \frac{s}{n-1}\right) \tag{3}$$

where $\sigma_{i,t}$ denotes the market share of bank i in period t and $\alpha_1 = \frac{\partial \Pr_{i\to i,t}}{\partial p_{i,t}} = \frac{\partial \Pr_{iR\to i,t}}{\partial p_{i,t}} < 0$, since the probability of the borrower borrowing from bank i should be decreasing in the interest rate charged by bank i. Also, α_0^i are bank-specific intercepts which capture bank heterogeneity, and $\overline{p}_{iR}$ is the average interest rate charged by rival banks.

The borrower "lock-in" effect created by the presence of switching costs is captured by the persistence in bank i's market share, i.e. by the fact that the derivative in equation (4) has a positive sign.

$$\frac{\partial \sigma_{i,t}}{\partial \sigma_{i,t-1}} = -\frac{n}{n-1}s\alpha_1 > 0 \tag{4}$$

Also notice that the "lock-in" effect is increasing in the magnitude of switching costs.

The total switching-cost effect is termed as:

$$\frac{\partial \sigma_{i,t}}{\partial s} = \left(\frac{1}{n} - \sigma_{i,t-1}\right)\frac{n}{n-1}\alpha_1 \begin{array}{l} < 0 \text{ if } \sigma_{i,t-1} < 1/n \\ > 0 \text{ if } \sigma_{i,t-1} > 1/n \end{array} \tag{5}$$

which is the effect of switching costs on current market shares. Equation (5) indicates that an increase in s lowers the market share for smaller than average banks, and raises it for those larger than average.

2.1.2 Supply

On the supply side, in every period t bank i chooses the interest rate on loans p_i to maximize the present value of her lifetime profits.

From the bank's optimal interest rate strategy and the demand transition probabilities, KKV obtain an expression for the price-cost margin charged by bank i, $pcm_i = (p_i - c_i)$, where c_i is the per-unit cost of loans. Thus:

$$pcm_{i,t} = -\delta \cdot \sigma_{i,t+1}\frac{n}{n-1}sg_{t+1} - \frac{\sigma_{i,t}}{\alpha_1} \tag{6}$$

where δ is the one-period discount factor for the bank and g_t is the market growth rate of loans in period t.

The first term in equation (6) captures what has been labeled the *"investment" effect* on price-cost margins. In the presence of switching costs, the bank charges an interest rate lower than that indicated by pure oligopoly power ($-\frac{\sigma_{i,t}}{\alpha_1}$) as a way to "invest" and capture borrowers that will be "locked-in" in the future. Notice that $-\delta \cdot \sigma_{i,t+1}\frac{n}{n-1}sg_{t+1} < 0$ so that $pcm_{i,t} < -\frac{\sigma_{i,t}}{\alpha_1}$. Therefore, the market share $\sigma_{i,t+1}$ will be larger than it would be without this "investment". The second term in equation (6) captures the *"harvesting" effect* on price-cost margins. After the "investment" in period t, in period $t+1$ bank i harvests per-unit profits of $-\frac{\sigma_{i,t+1}}{\alpha_1}$[5].

2.2 Empirical Strategy

Two estimation equations are obtained from the KKV model. From the demand-side, an equation for the transition probability of bank i's market share (equation (3)). From the supply-side, the pricing equation for loans (equation (6)).

In order to make the estimation possible, we first-difference equation (3) to eliminate the bank specific intercept α_0^i. This yields a two-equation system with two unknowns given by:

$$\Delta\sigma_{i,t+1} = -\Delta\sigma_{i,t}\frac{n}{n-1}s\alpha_1 + \alpha_1(\Delta p_{i,t+1} - \Delta\overline{p}_{-i,t+1}) + \zeta_{it+1} \tag{7}$$

and

$$pcm_{i,t} = -\delta \cdot \sigma_{i,t+1}\frac{n}{n-1}sg_{t+1} - \frac{\sigma_{i,t}}{\alpha_1} + \omega_{it} \tag{8}$$

where Δ denotes first-order difference.

For the demand transition probabilities, ζ_{it+1} is assumed to be unobservable shocks to demand and assumed to be exogenous to bank specific cost shifters (z^c):

$$E\left[\zeta_{it+1}(s,\alpha_1)|\Delta z^c\right] = 0$$

We follow Dick (2007) and use the first differences of a bundle of costs shifters as instruments of the lending rate. These include the wage rate, the deposits rate, the federal funds rate, expenses on premises and fixed assets, the cash to assets ratio, the shares of real estate loans and loans to individuals in total assets, and credit risk measures[6].

[5] Recall that $\alpha_1 < 0$, so that the second term in equation (6) is positive.

[6] Dick (2007) uses a nested logit model to estimate a demand system in the local market for deposits in the U.S.

In the supply side equation, ω_{it} is assumed to be an unobservable shock to price-cost margins and assumed to be exogenous to bank specific demand shifters (z^d) after controlling for bank and time fixed effects:[7]

$$E\left[\omega_{it}(s,\alpha_1)|z^d\right] = 0$$

As demand shifters we use the lead market shares in deposits and the pool of employees, and several lags of market shares in loans, deposits and the pool of employees.

We then form the vector of sample moment conditions as a function of parameters which is given by:

$$g(s,\alpha_1) = \frac{1}{n}\Sigma_{it}\begin{bmatrix}\omega_{it}(s,\alpha_1)z^d \\ \zeta_{it+1}(s,\alpha_1)\Delta z^c\end{bmatrix}$$

where n is the total number of observations in the sample. The GMM estimators are:

$$(\widehat{s},\widehat{\alpha}_1)_{GMM} = \arg\min_{s,\alpha_1} g(s,\alpha_1)'Wg(s,\alpha_1)$$

where W is a weighting matrix.

We use the rolling method to estimate the switching costs for each period and to form a time series of estimates $\mathbf{S} = (S_1, S_2, ..., S_T)$. In the rolling estimation, the switching costs at period t (S_t) are estimated using the data for six years before period t.

Following KKV, we assume the maturity of loan contracts to be at most three years. Notice that an increase in the length of maturity will dramatically reduce the number of observations that can be used for estimation, since both one lead and one lag of the variables used as instruments are needed. We estimated S assuming shorter maturities (1 or 2 years) as a robustness test, and found that the estimates tend to decline as the assumed maturity length increases. This is consistent with KKV, who find that borrowers hardly switch in this case.

2.2.1 Data

We collect banking data from the Consolidated Reports on Condition and Income (CALL Reports). These are bank-level balance sheet and income statement data available from the Federal Reserve

[7]To avoid dealing with an over-parametrization problem, instead of introducing bank and time dummy variables, we bank and time demean the variables to control for these fixed effects.

Bank of Chicago for all banks regulated by the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Comptroller of the Currency. We work with quarterly data from 1985 to 2009. In the appendix we provide more details on the treatment of these data. In total our data includes 638,392 bank-quarter observations or on average 8,305 banks per quarter. We consider our data as a comprehensive sample of the banking industry in the U.S. since it covers more than 97% of commercial banks.

Because lending rates are not reported in bank statements, we need to impute them from information on interest income and loans. We use the ratio of interest income on loans to total loans to approximate loan rates at the bank-level. Similarly, we approximate deposit rates at the bank-level as the ratio of interest expenses on deposits to total deposits. Finally, we calculate price-cost margins as the difference between loan and deposit rates.

We use Treasury bill rates to construct banks discount factors, assuming that they accurately reflect the opportunity cost of funds for banks.

Last, all variables are measured in 2000 constant U.S. dollars, and deflated using the consumer price index (CPI).

2.3 Empirical Results

The estimated switching costs are shown in Figure 1. The estimates are significant at least at the 5% level, which indicates the existence of significant switching costs in the U.S. banking system.[8] The thick solid line shows the point estimates of the switching costs, and the dashed line is the lower boundary of the 10% confidence interval.

It is evident from this figure that switching costs decreased from around 30% in 1994 to around 4% to 5% in 2001 and 2002 and increased back to around 16% to 20% at the end of 2006. In this sense, it is worth noting that our structural estimates do not measure the borrowers "direct pecuniary" costs of switching banks only. Consistent with the model in Kim, Kliger and Vale (2003), they capture the "economic costs associated with the capitalized value of long-term customer bank relationships". Therefore, the observed structural break in the pattern followed by switching costs may have resulted from the important deregulation efforts that took place at the end of the

[8]4 out of 51 estimated switching costs are significant at the 10% level and the other 47 are at least at the 5% level.

last decade, particularly those related to the elimination of interstate branching restrictions. Our hypothesis is that as banks' geographical coverage expanded, borrowers should have started to find it easier to switch lenders[9].

3 The Bank Lending Channel

In this section we apply the identification strategy in Arena, Reinhart and Vazquez (2006) to study the impact of switching costs on the bank lending channel of monetary transmission. Specifically, we use the specification of equation (9) below, and estimate it using standard OLS.

With this specification, we seek to estimate the first derivative $\partial L^s_{it}/\partial M_t$, and the cross-derivative $\partial L^s_{it}/\partial M_t \partial S_t$, where L^s_{it} is the loan supply of bank i at time t, and M_t and S_t are measures of the stance of monetary policy and of switching costs at time t. A negative sign for the first derivative provides evidence in support of the bank lending channel. The sign for the cross-derivative shows whether switching costs for borrowers strengthen or weaken this channel.

Thus, the equation we estimate is:

$$\begin{aligned}
\Delta \log(L_{it}) \quad = \quad & \alpha_0 + \alpha_1 T + \alpha_2 T^2 + \sum_{j=1}^{4} \beta_j \Delta \log(L_{it-j}) + \sum_{j=1}^{4} \gamma_j \Delta \log(GDP_{t-j}) \\
& + \sum_{j=1}^{4} \delta_j \Delta M_{t-j} + \sum_{j=1}^{4} \theta_j S_{t-j} + \sum_{j=1}^{4} \phi_j S_{t-j} \Delta M_{t-j} \\
& + \rho_1 c_{1i,c,t-1} + \rho_2 c_{2i,c,t-1} + \rho_3 c_{3i,c,t-1} \\
& + control\ dummies + \varepsilon_{it}
\end{aligned} \tag{9}$$

In this equation i indexes each individual bank, and t denotes time. Equation (9) relates the volume of loans (L) to an indicator of the stance of monetary policy (M) and a measure of switching costs in banking (S). The switching costs measure is the estimate for each period obtained in Section 2 and presented in Figure 1. To model the effects of switching costs on the bank lending channel of monetary policy we interact the switching costs S with the monetary policy indicator M at various lags.

[9] Studying in depth the causes of this change in the pattern followed by switching costs is beyond the scope of our paper. We leave this for future work.

To capture possible time effects, we include both linear (T) and quadratic (T^2) time trend terms as dictated by the Akaike Information Criterion (AIC). Last, $\varepsilon_{i,t}$ are the unobservable bank-level, time-varying shocks.

Notice that we have added the lagged dependent variable among the regressors following Kashyap and Stein (2000) and Ashcraft (2006).

Market size varies substantially over time in our sample. Therefore, to avoid a given change in the stance of monetary policy to have a larger impact on the volume of loans in larger markets, we use the percentage change in loans as the dependent variable instead of the volume of loans itself.

We follow Adams and Amel (2005) and Ashcraft (2006) and assume that monetary policy shifts banks' marginal costs by affecting the interest rates they must pay for loanable funds. Therefore, for the measure of the stance of monetary policy (M), we use the first difference of short-term interest rates. Following previous empirical work on monetary policy in the U.S., we use the Federal Funds rate as an indicator of the stance of monetary policy.

We include the growth rate of GDP to control for changes in loan demand, and to isolate the effect of switching costs on the supply-side of the market for bank loans. The idea is that in this way the coefficients measure the effect of the various regressors on the supply of loans L^s_{it}, so that we can identify both the first and the cross derivatives discussed above. Thus, this helps us identify the *supply-side* bank lending channel from the alternative *demand-side* interest rate channel. We use several lags of GDP growth to avoid the potential endogeneity bias arising from GDP being influenced by the supply of credit.

Furthermore, using bank-level data allows us to apply the identification strategy of previous studies based on the widely agreed notion that banks facing different degrees of financial constraints adjust their supply of credit differently to monetary shocks[10]. Thus, the idea is to test for cross-sectional differences in the response of bank lending to monetary shocks across heterogeneous banks facing different financial constraints[11].

Since financial constraints cannot be directly measured, here we follow the standard practice in

[10]See Peltzman (1969), Kashyap and Stein (1995 and 2000), Cecchetti (1999), Favero et al (1999), Kishan and Opiela (2000) and Ashcraft (2006), among others.

[11]Also, having these controls for bank-level characteristics should result in more efficient estimates of the coefficients of interest on the monetary policy indicator and the interaction term.

the literature of using two specific bank characteristics, liquidity and capitalization, to proxy for these heterogeneities in financial constraints. The degree of liquidity (c_1) is computed as the ratio of cash to total assets. The degree of capitalization (c_2) is computed as the ratio of equity capital to total assets. The assumption is that more liquid and better capitalized banks tend to pay a lower risk premium for non-insured debt, and are therefore, better prepared to isolate their loans from unexpected monetary policy-induced shocks to deposits. We also include a measure of bank size (c_3), which can capture other elements unrelated to banks' financial constraints. The argument is that bigger banks might find it easier to issue market instruments, which would make them better prepared to face negative monetary shocks. Following Arena et al (2007) and to eliminate possible trends in the measure of size, we use a relative measure, calculated as the difference between the logarithm of total assets of a bank in a given period, and the average of the logarithm of assets across all banks in that period:

$$c_{3i,t} = ln(assets_{i,t}) - \frac{\sum_{i=1}^{n_t} ln(assets_{i,t})}{n_t} \tag{10}$$

where n_t represents the number of banks at time t.[12]

There are three endogeneity concerns associated with these bank-level controls. First, bank size may be endogenous to loan growth. Second, it is not clear that better capitalized banks are less financially constrained, i.e. a bank may choose to raise more equity only because it faces a higher external finance premium at first. Third, bank liquidity can also be a biased measure of financial constraints if banks optimally choose to have a more liquid asset structure just to compensate for higher financing restrictions. Therefore, to reduce potential bias to the regression coefficients associated to these endogeneities, we follow Arena et al (2007) and use the lagged values of these bank-level characteristics in equation (9).

Following Aliaga-Díaz and Olivero (2010), we introduce dummy variables to control for two important regulatory changes that took place in the United States banking sector during the period covered by this study. First, in 1994 the Riegle-Neal Interstate Banking Act allowed national banks to operate branches across states after June 1, 1997. Second, the Gramm-Leach-Bliley Act enacted in November of 1999 increased the number of activities allowed for banks. We also control for seasonal effects in the quarterly data by introducing quarterly dummies, and for potential geographic

[12]As a robustness test we also used an absolute measure of bank size ($\ln(assets_{i,t})$) instead of this relative measure. The results are very similar and available from the authors upon request.

heterogeneities by introducing Federal Reserve-district dummy variables[13].

We also convert all variables which involve interaction terms into deviation scores, which lets the coefficients of the linear terms be interpreted as the overall effects when the interacted variable is evaluated at its sample mean[14]. Also, when estimating equation (9) we compute heteroscedasticity and autocorrelation-robust standard errors.

Last, to show that the inclusion of our generated switching costs is based on the valid assumption that the bank lending channel is at work, we estimate equation (9) with and without including S and $S \cdot \Delta M$, respectively. The comparison of the results for these two specifications is useful to test whether the inclusion of switching costs changes the results for the standard model of the bank lending channel.

The coefficients of interest are $\sum_{j=1}^{4} \delta_j$ and $\sum_{j=1}^{4} \phi_j$. $\sum_{j=1}^{4} \delta_j$ measures the *overall effect* of monetary policy on the loan supply schedule when switching costs are held at their mean. $\sum_{j=1}^{4} \phi_j$ measures its *marginal effect* when switching costs deviate from its mean. We expect an increase in interest rates to reduce the growth of bank lending, so that the value of $\sum_{j=1}^{4} \delta_j$ should be negative, providing evidence in support of the existence of the bank lending channel. Also, based on our discussion in the introduction, the presence of borrowers switching costs should strengthen the bank lending channel. Thus, $\sum_{j=1}^{4} \phi_j$ should also be negative.

3.1 Data

Data on macroeconomic variables including CPI, GDP, Treasury bill rates and the Federal Funds rate are from the Board of Governors of the Federal Reserve System.

Bank-level data are from the Call Reports as presented in section 2.2.1, and summarized in the data appendix.

[13]Following Kashyap and Stein (2000) and Cetorelli and Goldberg (2009), we also tried introducing state dummy variables, but the results do not change significantly.

[14]See Aiken and West (1991) for a detailed discussion of centering data in the presence of interaction terms.

3.2 Empirical Results

Table 1a shows the results of our benchmark bank lending channel regression[15]. At first we ignore the impact of switching costs on the bank lending channel, by estimating equation (9) without including the switching costs variables. The first column of Table 1a shows the results of this exercise. Having controlled for demand effects, the δ coefficients capture the supply-side effects of monetary policy on the market for credit. Thus, these negative values support the idea that the bank lending channel is at work in the United States, and the validity of the specification of equation (9). The coefficients on real GDP growth are positive, and they indicate an increase in the demand for bank credit when real GDP is growing.

The results of equation (9) are reported in the second column of Table 1a. The inclusion of the switching costs has no qualitative effects on the control variables, and monetary policy tightenings keep having a negative effect on loan growth, which indicates the validity of the inclusion of the switching costs measure. The coefficient on the interaction term $S \cdot \Delta M$ has the expected negative sign. This supports our conjecture in the introduction that the real effects of monetary policy are increasing in the magnitude of switching costs. When borrowers cannot costlessly switch lenders after a monetary tightening, the excess demand for credit left by small, financially constrained banks cannot be "picked up" by larger, less constrained banks. Therefore, the aggregate supply of loans shrinks by more, and the real effects of policy are stronger the larger these switching costs.

Table 1b shows the percentage change in bank lending as a result of a one percentage point increase in the stance of monetary policy, for several levels of the switching costs. Since we use deviation scores of S and ΔM, the coefficient of ΔM itself is the percentage change in lending after a one percentage point increase in the Federal Funds rate when switching costs are at their mean. The coefficient suggests that a one percentage point increase in the Federal Funds rate will decrease bank lending by around 2.20%, which is higher than the results for the standard bank lending channel shown in the first column of Table 1a (i.e. 1.06%). Also evident from Table 1b is that monetary policy becomes more effective as switching costs rise. For example, in economies where S is at the 25^{th} percentile of its distribution, a one percentage point increase in the stance of monetary policy induces a 1.03% reduction in the supply of loans. In economies where borrowers

[15] Although not reported here, the coefficients on the time, seasonal and Federal Reserve-district dummy variables are all highly significant.

find it more costly to switch lenders, i.e. in economies where S is at the 75^{th} percentile of its distribution, a monetary policy tightening of the same magnitude induces the supply of credit to fall by 3.21%, a reduction three times larger.

Furthermore, the coefficient on switching costs themselves is negative, suggesting that the supply of credit tends to grow at a lower rate as these costs rise.

Regarding the effects on the supply of credit of the strength of banks balance sheets, estimation results indicate that increased liquidity in the previous period consistently lead to faster current loan growth. They also show that smaller and more capitalized banks exhibit slower loan growth.

3.2.1 On the Effects of Banks Financial Constraints

It is widely accepted that banks facing different degrees of financial constraints adjust their supply of credit differently in response to monetary shocks. Bank size, liquidity and capitalization are often used in the literature to proxy for these financial constraints.

Banks of different size respond differently to monetary shocks mainly for two reasons. First, small banks often have simpler capital structures and finance their loans mostly through transaction and savings deposits. When the money supply shrinks, these banks are not able to maintain their loan supply by resorting to cash or securities. Second, smaller banks have larger costs of dealing with the informational asymmetries involved in raising uninsured funds to finance their lending (see Peltzman (1969)). It is also known that less capitalized banks find it more difficult to obtain funding through capital markets to protect their loan portfolios (see Kashyap and Stein (1995 and 2000), Favero et al (1999) and Kishan and Opiela (2000), among others).

Exploiting our bank-level data, we are able to study this feature of the bank lending channel of monetary policy. Following Ashcraft (2006), we now add additional terms to the regressors in equation (9) by interacting the lagged bank-level characteristics c_1, c_2 and c_3 with the monetary policy indicators. Therefore, the equation we estimate is:

$$
\begin{aligned}
\Delta \log(L_{it}) \quad = \quad & \alpha_0 + \alpha_1 T + \alpha_2 T^2 + \sum_{j=1}^{4} \beta_j \Delta \log(L_{it-j}) + \sum_{j=1}^{4} \gamma_j \Delta \log(GDP_{t-j}) \qquad (11) \\
& + \sum_{j=1}^{4} \delta_j \Delta M_{t-j} + \sum_{j=1}^{4} \theta_j S_{t-j} + \sum_{j=1}^{4} \phi_j S_{t-j} \Delta M_{t-j} \\
& + \sum_{j=1}^{4} \psi_{1j} \Delta M_{t-j} c_{1i,c,t-1} + \sum_{j=1}^{4} \psi_{2j} \Delta M_{t-j} c_{2i,c,t-1} + \sum_{j=1}^{4} \psi_{3j} \Delta M_{t-j} c_{3i,c,t-1} \\
& + \rho_1 c_{1i,c,t-1} + \rho_2 c_{2i,c,t-1} + \rho_3 c_{3i,c,t-1} \\
& + control\ dummies + \varepsilon_{it}
\end{aligned}
$$

We do this with two goals in mind. First, to examine whether the estimated switching costs are only another proxy for these financial constraints of the banking system. If this was the case, then the inclusion of these three interaction terms is likely to wash out the effect of $S \cdot \Delta M$, and make the ϕ_j coefficients insignificant. Second, these additional terms help to better identify the *supply-side* bank lending channel, by testing the prediction that banks heterogeneous in their degree of financial constraints will react differently to monetary policy (i.e. the coefficients ψ_1, ψ_2 and ψ_3 are expected to be positive).

These results are presented in Table 2. All coefficients of ΔM and S keep their significant negative signs. Since the effects of the switching costs on lending are not "picked up" by these three proxies, this indicates that switching costs are not just a proxy for financial constraints in the banking industry. Therefore, from this exercise we can conclude that switching costs have an effect on the transmission of monetary policy that is independent from the effect of financial constraints in the banking sector itself, as measured by banks' sizes, and the degree of liquidity and capitalization of their balance sheets.

We also test for cross-sectional differences across heterogeneous banks in the impact of switching costs on the transmission of monetary policy. With this goal, we perform three exercises, partitioning our sample into sub-samples according to the degree of financial constraints faced by banks, as measured by their size (Tables 3a and 3b), liquidity (Tables 4a and 4b) and capitalization (Tables 5a and 5b), respectively.

The results of each sub-sample are similar to those for the entire sample. Results are robust across these size, liquidity and capitalization categories, in the sense that within each group the bank lending channel is still at work, and monetary policy always becomes more effective as switching costs rise for borrowers.

Table 3b shows the percentage change in lending by size categories given a one percentage point increase in the Federal Funds rate. For all three sub-samples, the bank lending channel is strengthened with higher switching costs. When the switching costs are at their mean level, banks above 75^{th} percentile by size will decrease lending by about 0.3 percentage points less than banks below 75^{th} percentile by size. This differential increases to about 0.4 percentage points when the switching costs are at the 75^{th} percentile. Summarizing, this table shows that the supply of loans is more sensitive to monetary shocks among small banks than among larger institutions, which is consistent with previous results by Kashyap and Stein (1995) and Kishan and Opiela (2000).

Regarding the response of the supply of loans to monetary shocks for banks with different degrees of liquidity, Table 4b shows that when the switching costs are above the 50^{th} percentile level, the more liquid banks (above the 25^{th} percentile) respond to monetary policy slightly less than less liquid banks (25^{th} percentile and below). Although the effect of the monetary policy on the lending is not monotonic over three sub-samples, to some extent these results also mirror the results of previous work that more liquid banks are less financially constrained, and therefore respond less to monetary policy. Thus, the results in Table 3 and 4 support the existence of supply-side effects in credit markets.

Tables 5a and 5b show the results for banks of different degrees of capitalization in their balance sheets. Again, results are robust, and all coefficients of interests are significantly negative. However, the effect of the Federal Funds rate on lending does not show the pattern we expect, i.e. that more capitalized banks respond less to monetary shocks. We will investigate this issue further in future work.

To further study the supply-side effects of monetary policy on credit markets and their relationship with switching costs, we follow Ashcraft (2006) and include one last set of additional controls in equation (9). These are the interaction terms between the c characteristics and the demand indicator ΔGDP, aimed at testing whether the presence of switching costs changes the response to demand shocks of heterogeneous banks. The equation we estimate now is:

$$
\begin{aligned}
\Delta \log(L_{it}) \quad = \quad & \alpha_0 + \alpha_1 T + \alpha_2 T^2 + \sum_{j=1}^{4} \beta_j \Delta \log(L_{it-j}) + \sum_{j=1}^{4} \gamma_j \Delta \log(GDP_{t-j}) \\
& + \sum_{j=1}^{4} \delta_j \Delta M_{t-j} + \sum_{j=1}^{4} \theta_j S_{t-j} + \sum_{j=1}^{4} \phi_j S_{t-j} \Delta M_{t-j} \\
& + \sum_{j=1}^{4} \psi_{1j} \Delta GDP_{t-j} c_{1i,c,t-1} + \sum_{j=1}^{4} \psi_{2j} \Delta GDP_{t-j} c_{2i,c,t-1} + \sum_{j=1}^{4} \psi_{3j} \Delta GDP_{t-j} c_{3i,c,t-1} \\
& + \rho_1 c_{1i,c,t-1} + \rho_2 c_{2i,c,t-1} + \rho_3 c_{3i,c,t-1} \\
& + control\ dummies + \varepsilon_{it}
\end{aligned} \tag{12}
$$

The results are reported in Table 6. All coefficients of ΔM and S are still significantly negative, which again supports the isolation of the effect of the switching costs on the lending channel. Also, the effect captured by these interaction terms is insignificant, which indicates that there is no evidence of systematic differences in the response to changes in loan demand across heterogeneous banks. These results offer even more evidence supporting the existence of supply-side effects in the market for bank loans in the U.S..

Last, we include the interactions of bank-level characteristics with both the monetary policy and the demand indicators. This larger set of controls allows us to further isolate the effect of switching costs on the transmission of monetary policy. The results are reported in Table 7. The fact that after the inclusion of these controls switching costs still have a significant effect on lending and that they still reinforce monetary transmission provides more evidence that these costs do indeed impact the environment in which monetary policy decisions are made, and their transmission to the real sector.

4 Conclusions

In this paper we study the relationship between switching costs for bank-dependent borrowers and the effectiveness of monetary policy through the bank lending channel. To the best of our knowledge, this is the first effort in the literature to explicitly examine the effects of switching costs on the bank lending channel.

We proceed in two steps. In the first we apply the structural I.O. model of Kim, Kliger and

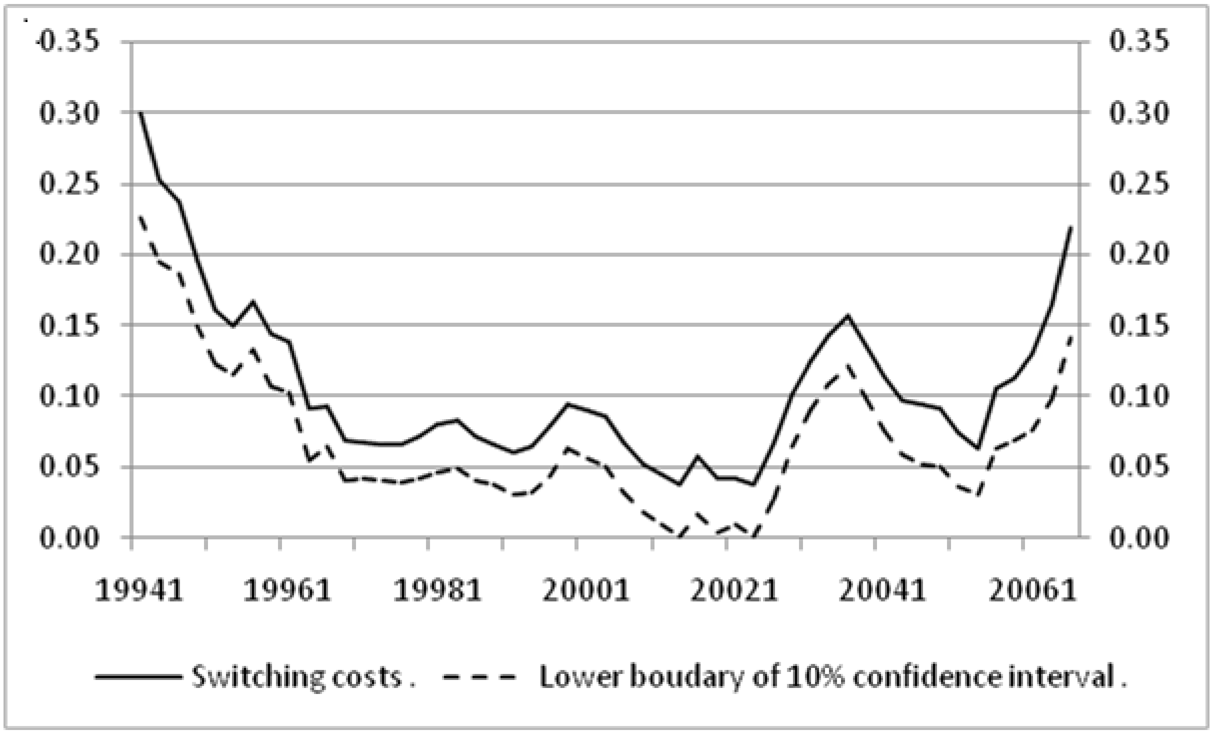
Vale (2003) to estimate the switching costs for borrowers of commercial banks in the U.S.. We find that switching costs have followed a downward trend from around 30% in 1994 to around 4% to 5% in 2001 and 2002 and increased back to around 16% to 20% at the end of 2006.

In the second step we assess how these costs affect the environment in which monetary policy is conducted, and its transmission to the rest of the economy through the bank lending channel. We find that these costs have an important impact on the effectiveness of monetary policy, and that this effect is independent from that of financial constraints of the banking industry itself. Specifically, the higher the switching costs, the larger the impact that monetary policy shocks have on the real sector.

Our results have policy implications particularly relevant at a time when monetary policy is being heavily used as a stabilisation device around the world, while the financial crisis is leading to significant market structure changes in banking, which in turn can impact the magnitude of the switching costs that we study in this paper.

An interesting area for further research is to extend this work to a sample of developed and emerging economies, to be able to make a cross-country comparison of both the magnitude of switching costs and their role on the transmission of the monetary policy. Doing so would also allow us to uncover some interesting patterns regarding the macroeconomic and financial determinants of switching costs. We leave this for future work.

Figure 1: Borrowers' Switching Costs in the U.S.



Estimates are significant at the 5% level based on a one-tail test.

Source: Own estimates of the model in Kim, Kliger and Vale (2003) using data for the period 1985-2009 for the United States.

Table 1a: Switching Costs and the Bank Lending Channel: Benchmark Model

	No Switching Costs	Switching Costs
ΔM and S		
$\Sigma_{j=1}^{4} S_{t-j}$		-0.0232***
		(0.0063)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-1.0627***	-2.1973***
	(0.0504)	(0.0946)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$		-30.7564***
		(1.6983)
Controls		
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	2.8760***	3.2664***
	(0.1068)	(0.1610)
Size_{t-1}	0.0003**	0.0003**
	(0.0001)	(0.0001)
Liquidity_{t-1}	0.0087**	0.0081*
	(0.0042)	(0.0042)
$\text{Capitalization}_{t-1}$	-0.0149***	-0.0146***
	(0.0052)	(0.0052)
F Stat	825.74	683.59
Adj. R^2	0.16	0.16
# Obs.	329,504	329,504

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 1b: Percentage Change in Lending as a Result of a 1% Change in the Federal Funds Rate - Benchmark Model

S=0.1046	(sample mean)	-2.1973***
S=0.0665	(25^{th} percentile)	-1.0265***
S=0.0911	(50^{th} percentile)	-1.7820***
S=0.1378	(75^{th} percentile)	-3.2173***

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 2: Switching Costs and the Bank Lending Channel: Robustness Check

	No Switching Costs	Switching Costs
ΔM and S		
$\Sigma_{j=1}^{4} S_{t-j}$		-0.0229***
		(0.0063)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-1.0508***	-2.1819***
	(0.0510)	(0.0952)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$		-30.6912***
		(1.6972)
Controls		
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	2.8681***	3.2523***
	(0.1070)	(0.1612)
Size_{t-1}	0.0003**	0.0003**
	(0.0001)	(0.0001)
Liquidity_{t-1}	0.0095**	0.0089**
	(0.0041)	(0.0041)
$\text{Capitalization}_{t-1}$	-0.0142***	-0.0138***
	(0.0053)	(0.0053)
Additional Interaction Terms		
$\Sigma_{j=1}^{4} \Delta M_{t-j} \text{Size}_{t-1}$	0.0058	0.0027
	(0.0347)	(0.0347)
$\Sigma_{j=1}^{4} \Delta M_{t-j} \text{Liquidity}_{t-1}$	0.5254	0.4797
	(1.4269)	(1.4264)
$\Sigma_{j=1}^{4} \Delta M_{t-j} \text{Capitalization}_{t-1}$	2.9023*	2.7841*
	(1.4991)	(1.4981)
F Stat	614.51	536.60
Adj. R^2	0.16	0.16
# Obs.	329,504	329,504

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 3a: Switching Costs and the Bank Lending Channel: Subsamples by Bank Size

	No Switching Costs			Switching Costs		
	25^{th} percentile	$25^{th} - 75^{th}$ percentile	$75^{th}+$ percentile	25^{th} percentile	$25^{th} - 75^{th}$ percentile	$75^{th}+$ percentile
ΔM and S						
$\Sigma_{j=1}^{4} S_{t-j}$				-0.0616***	-0.0145*	0.0008
				(0.0150)	(0.0081)	(0.0118)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-0.9300***	-1.0848***	-0.9436***	-2.1943***	-2.1619***	-1.8699***
	(0.1134)	(0.0650)	(0.1033)	(0.2186)	(0.1204)	(0.1899)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$				-33.7568***	-29.1691***	-25.9353***
				(3.9020)	(2.2080)	(3.2653)
Controls						
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	2.9609***	2.8147***	2.5282***	3.5477***	3.1689***	2.7401***
	(0.2391)	(0.1386)	(0.2167)	(0.3688)	(0.2044)	(0.3290)
Size_{t-1}	0.0000	-0.0040***	-0.0027***	0.0000	-0.0040***	-0.0027***
	(0.0006)	(0.0003)	(0.0003)	(0.0006)	(0.0003)	(0.0003)
Liquidity_{t-1}	0.0116*	0.0309***	-0.0125	0.0115*	0.0301***	-0.0128
	(0.0060)	(0.0059)	(0.0124)	(0.0061)	(0.0059)	(0.0124)
$\text{Capitalization}_{t-1}$	0.0019	-0.0129*	-0.0274*	0.0023	-0.0126*	-0.0271*
	(0.0084)	(0.0069)	(0.0147)	(0.0084)	(0.0069)	(0.0147)
F Stat	300.86	532.10	110.31	246.76	438.85	92.32
Adj. R^2	0.19	0.19	0.11	0.20	0.19	0.11
# Obs.	82,033	168,170	79,301	82,033	168,170	79,301

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 3b: Percentage Change in Lending as a Result of a 1% Change in the Federal Funds Rate by distribution of bank size

		25^{th} percentile	25^{th} - 75^{th} percentile	75^{th} percentile
S=0.1046	(sample mean)	-2.1943***	-2.1619***	-1.8699***
S=0.0665	(25^{th} percentile)	-0.9094***	-1.0515***	-0.8826***
S=0.0911	(50^{th} percentile)	-1.7385***	-1.7680***	-1.5197***
S=0.1378	(75^{th} percentile)	-3.3138***	-3.1292***	-2.7300***

A * denotes estimates significant at 10% level, a ** denotes estimates significant at 5% level,

a *** denotes estimates significant at 1% level.

Table 4a: Switching Costs and the Bank Lending Channel: Subsamples by Bank Liquidity

	No Switching Costs			**Switching Costs**		
	25^{th} percentile	$25^{th}-75^{th}$ percentile	$75^{th}+$ percentile	25^{th} percentile	$25^{th}-75^{th}$ percentile	$75^{th}+$ percentile
ΔM and S						
$\Sigma_{j=1}^{4} S_{t-j}$				-0.0487***	-0.0100	-0.0181
				(0.0114)	(0.0086)	(0.0154)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-1.0945***	-1.0457***	-1.0738***	-2.5865***	-2.1590***	-2.0175***
	(0.0946)	(0.0664)	(0.1187)	(0.1809)	(0.1254)	(0.2244)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$				-41.0169***	-32.4821***	-22.1609***
				(3.2404)	(2.2443)	(4.0836)
Controls						
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	2.4751***	2.7868***	3.1615***	2.6271***	2.9579***	3.9989***
	(0.2043)	(0.1412)	(0.2424)	(0.3127)	(0.2133)	(0.3744)
Size_{t-1}	-0.0008***	0.0004***	0.0005*	-0.0008***	0.0004***	0.0005*
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)
Liquidity_{t-1}	0.1475***	0.1785***	0.0246***	0.1442***	0.1773***	0.0247***
	(0.0293)	(0.0109)	(0.0059)	(0.0292)	(0.0109)	(0.0059)
$\text{Capitalization}_{t-1}$	-0.0176*	-0.0148**	-0.0130	-0.0179*	-0.0144**	-0.0126
	(0.0104)	(0.0066)	(0.0103)	(0.0104)	(0.0066)	(0.0103)
F Stat	231.77	505.85	190.16	191.96	420.71	155.74
Adj. R^2	0.18	0.17	0.14	0.18	0.18	0.14
# Obs.	84,763	163,738	81,003	84,763	163,738	81,003

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 4b: Percentage Change in Lending as a Result of a 1% Change in the Federal Funds Rate by Bank Liquidity

		25^{th} percentile	25^{th} - 75^{th} percentile	75^{th} percentile
S=0.1046	(sample mean)	-2.5865***	-2.1590***	-2.0175***
S=0.0665	(25^{th} percentile)	-1.0251***	-0.9225***	-1.1739***
S=0.0911	(50^{th} percentile)	-2.0326***	-1.7204***	-1.7182***
S=0.1378	(75^{th} percentile)	-3.9467***	-3.2362***	-2.7524***

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 5a: Switching Costs and the Bank Lending Channel: Subsamples by Bank Capitalization

	No Switching Costs			Switching Costs		
	25^{th} percentile	$25^{th}-75^{th}$ percentile	$75^{th}+$ percentile	25^{th} percentile	$25^{th}-75^{th}$ percentile	$75^{th}+$ percentile
ΔM and S						
$\Sigma_{j=1}^{4} S_{t-j}$				-0.0193	-0.0150*	-0.0436***
				(0.0126)	(0.0079)	(0.0155)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-0.8614***	-1.1276***	-1.0434***	-1.9820***	-2.2905***	-2.0215***
	(0.0984)	(0.0658)	(0.1165)	(0.1788)	(0.1225)	(0.2280)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$				-33.0418***	-29.8324***	-27.5992***
				(3.3690)	(2.1435)	(4.0785)
Controls						
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	2.4472***	2.8461***	3.3329***	2.5533***	3.3717***	3.7366***
	(0.2150)	(0.1369)	(0.2489)	(0.3038)	(0.2091)	(0.3893)
Size_{t-1}	0.0008***	0.0006***	-0.0012***	0.0008***	0.0006***	-0.0012***
	(0.0002)	(0.0001)	(0.0003)	(0.0002)	(0.0001)	(0.0003)
Liquidity_{t-1}	0.0152**	0.0146***	-0.0043	0.0146**	0.0139***	-0.0044
	(0.0065)	(0.0048)	(0.0098)	(0.0065)	(0.0048)	(0.0098)
$\text{Capitalization}_{t-1}$	0.6495***	0.2511***	0.0042	0.6491***	0.2512***	0.0043
	(0.0378)	(0.0157)	(0.0099)	(0.0380)	(0.0157)	(0.0099)
F Stat	213.45	501.93	208.56	175.62	414.09	173.72
Adj. R^2	0.15	0.17	0.18	0.15	0.17	0.18
# Obs.	82,189	167,154	80,161	82,189	167,154	80,161

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 5b: Percentage Change in Lending as a Result of a 1% Change in the Federal Funds Rate by Bank Capitalization

		25^{th} percentile	25^{th} - 75^{th} percentile	75^{th} percentile
S=0.1046	(sample mean)	-1.9820***	-2.2905***	-2.0215***
S=0.0665	(25^{th} percentile)	-0.7242***	-1.1549***	-0.9709***
S=0.0911	(50^{th} percentile)	-1.5358***	-1.8876***	-1.6488***
S=0.1378	(75^{th} percentile)	-3.0778***	-3.2798***	-2.9367***

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 6: Switching Costs and the Bank Lending Channel: Robustness Check

	No Switching Costs	**Switching Costs**
ΔM and S		
$\Sigma_{j=1}^{4} S_{t-j}$		-0.0230***
		(0.0063)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-1.0585***	-2.1944***
	(0.0505)	(0.0946)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$		-30.7574***
		(1.6999)
Controls		
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	1.5846***	1.8029***
	(0.0594)	(0.0882)
Size_{t-1}	0.0003**	0.0003**
	(0.0001)	(0.0001)
Liquidity_{t-1}	0.0090**	0.0084**
	(0.0042)	(0.0042)
$\text{Capitalization}_{t-1}$	-0.0149***	-0.0145***
	(0.0053)	(0.0053)
Additional Interaction Terms		
$\Sigma_{j=1}^{4} \Delta GDP_{t-j} \text{Size}_{t-1}$	-0.0907**	-0.0870**
	(0.0403)	(0.0403)
$\Sigma_{j=1}^{4} \Delta GDP_{t-j} \text{Liquidity}_{t-1}$	0.3702	0.5650
	(1.5681)	(1.5714)
$\Sigma_{j=1}^{4} \Delta GDP_{t-j} \text{Capitalization}_{t-1}$	-0.4228	-0.1963
	(1.8120)	(1.8098)
F Stat	615.42	536.56
Adj. R^2	0.16	0.17
# Obs.	329,504	329,504

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

Table 7: Switching Costs and the Bank Lending Channel: Robustness Check

	No Switching Costs	Switching Costs
ΔM and S		
$\Sigma_{j=1}^{4} S_{t-j}$		-0.0226***
		(0.0063)
$\Sigma_{j=1}^{4} \Delta M_{t-j}$	-1.0433***	-2.1745***
	(0.0510)	(0.0952)
$\Sigma_{j=1}^{4} S_{t-j} \Delta M_{t-j}$		-30.6624***
		(1.6975)
Controls		
$\Sigma_{j=1}^{4} \Delta GDP_{t-j}$	1.5736***	1.7883***
	(0.0594)	(0.0883)
Size_{t-1}	0.0003***	0.0003***
	(0.0001)	(0.0001)
Liquidity_{t-1}	0.0098**	0.0092**
	(0.0041)	(0.0041)
$\text{Capitalization}_{t-1}$	-0.0137**	-0.0133**
	(0.0053)	(0.0053)
Additional Interaction Terms		
$\Sigma_{j=1}^{4} \Delta M_{t-j} \text{Size}_{t-1}$	0.1269***	0.1216***
	(0.0373)	(0.0372)
$\Sigma_{j=1}^{4} \Delta M_{t-j} \text{Liquidity}_{t-1}$	0.4936	0.3715
	(1.3914)	(1.3918)
$\Sigma_{j=1}^{4} \Delta M_{t-j} \text{Capitalization}_{t-1}$	3.2303*	2.9972*
	(1.6758)	(1.6750)
$\Sigma_{j=1}^{4} \Delta GDP_{t-j} \text{Size}_{t-1}$	-0.2246***	-0.2198***
	(0.0441)	(0.0440)
$\Sigma_{j=1}^{4} \Delta GDP_{t-j} \text{Liquidity}_{t-1}$	-0.1953	0.0522
	(1.5022)	(1.5039)
$\Sigma_{j=1}^{4} \Delta GDP_{t-j} \text{Capitalization}_{t-1}$	-2.0882	-1.9206
	(1.9855)	(1.9834)
F Stat	492.88	444.20
Adj. R^2	0.16	0.17
# Obs.	329,504	329,504

A *, **, *** denotes estimate is significant at the 10%, 5%, 1% level, respectively.

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Data Appendix

We use data for the period 1985-2009 to estimate switching costs for the period 1994-2006. The rolling window fixed size is 6 years and three maturity lags are needed for estimations, so that the first available estimate is for 1994. Also, since our data runs only until 2009 and three maturity leads are needed for estimation of the switching costs, we cannot get estimates after 2006. Table A.1 provides the data summary statistics.

A.1 Data Cleaning Rules for the Switching Costs Estimation

We work only with commercial banks, since the switching costs among borrowers of commercial banks are likely to be different from those of borrowers facing other financial institutions. Also, Cohen and Mazzeo (2007) show that financial institutions of different types compete differently.

Since the estimation needs one maturity lead and one maturity lag, we drop the observations with missing values in either one maturity lead or one maturity lag or both. We also drop observations with missing instruments, those for which the deposit rate is above 20%, one observation for which the loan rate exceeds 50% and finally, one observation for which the net interest margin is above 10%. Finally, we end up with 638,392 bank-quarter observations or, on average, 8,305 banks per quarter left for the estimation of switching costs. We consider our data as a comprehensive sample of the banking industry in the U.S. since it covers more than 97% of commercial banks. The descriptive statistics are reported in Table A.1. Several facts are worth noting: The number of commercial banks per period ranges from 5,957 to 10,699, which reflects the fact that many banks exited the industry through mergers and acquisitions in the last decade. The maximum market share for an individual bank is around 14%, which indicates the presence of some mega-banks in our sample. The average loan rate in our sample is 5.73%, which is lower than the prime lending rate reported by the Federal Reserve. This is because the imputed lending rate is risk-adjusted. The minimum net interest margin is negative, which reflects banks practice of setting prices below marginal costs to "lock-in" new customers.

A.2 Data Cleaning Rules for the Bank Lending Channel Estimation

To eliminate potential outliers, in this step we drop observations with loan growth rates being outside of the mean plus/minus five standard deviations range. We also drop from the sample those banks that are likely to have been involved in a merger and/or an acquisition, defined as those for which the RIAD4356 variable in the Call Reports is not equal to zero.

Table A.1: Data Summary Statistics

	Mean	Std. Dev.	Min	Max
Switching Costs Estimation		Observations: 638,392		
Main Variables				
Market gross growth rate ($totalloans_{t+1}/totalloans_t$)	1.4107	0.1949	1.1165	1.8490
CPI	89.5698	14.7588	65.6140	118.7719
Loan market share	0.0001	0.0017	0.0000	0.1381
No. of banks per quarter	8,305.20	1,651.60	5,957	10,699
Loan rate	0.0574	0.0283	0.0002	0.4888
Deposit rate	0.0237	0.0145	0.0000	0.1855
Net interest margin	0.0338	0.0176	-0.0675	0.4634
Treasury Bill Rate	0.0653	0.0163	0.0333	0.0942
Instruments				
Deposit market share	0.0001	0.0016	0.0000	0.1438
No. of Employees market share	0.0001	0.0015	0.0000	0.1248
Liquidity (cash/total assets)	0.0508	0.0429	0.0000	0.9688
Wage rate	0.0101	0.0062	0.0000	0.5027
Expenses on premises and fixed assets/ total assets	0.0027	0.0021	0.0000	0.1633
Individual loans (billions of US 2000 dollars)	0.0514	0.8772	0.0000	123.1732
Loan loss allowances (billions of US 2000 dollars)	0.0062	0.0961	0.0000	8.1164
Real estate loans/total assets	0.3113	0.1554	0.0000	0.9535
Federal Funds Rate	0.0515	0.0223	0.0098	0.0985
Bank Lending Channel Regression		Observations: 402,802		
Loan growth rate	0.0218	0.0758	-0.7755	0.8297
Federal Funds Rate	0.0425	0.0175	0.0100	0.0652
Real GDP growth rate	0.0079	0.0050	-0.0033	0.0193
log(total assets (millions of US 2000 dollars))	4.4681	1.2180	-0.0252	13.4416
Liquidity (cash/total assets)	0.0508	0.0429	0.0000	0.9688
Capitalization (equity/total assets)	0.1052	0.0454	0.0004	1.0000

Table A.2: Variable Definition

Variable	Definition	CALL Reports Variable
Market growth rate	Market total loans$_{t+1}$/Market total loans$_t$	RCFD1400
Loan market share	Bank's loans / Market total loans	RCFD1400 / Market total RCFD1400
Loan rate	Interest and fee income from loans / Total loans	RIAD4010 / RCFD1400
Deposit rate	Interest expenses on deposits / Deposits	RIAD4170 / RCFD2200
Net interest margin	Loan rate - Deposit rate	
Deposit market share	Bank's deposits / Market total deposits	RCFD2200 / Market total RCFD2200
No. of Employees market share	No. of bank's employees / Total No. of bank employees in the market	RIAD4150 / Market total RIAD4150
Liquidity	Cash / Total assets	RCFD0010 / RCFD2170
Wage rate	Salaries and benefits / Number of full time equivalent employees on payroll	RIAD4135/ RIAD4150
Expenses on premises and fixed assets/total assets	Expenses On Premises and Fixed Assets / Assets	RIAD4217 / RCFD2170
Individual loans (billions U$S)		RCFD1975
Loan loss allowances (billions U$S)		RCFD3123
Real estate loans/total assets		RCFD1410 / RCFD2170
Capitalization	Equity capital / Assets	RCFD3210 / RCFD2170