Re-examining the Transmission of Monetary Policy: What More Do a Million Observations Have to Say

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Abstract

In this paper we re–examine banks' lending behavior taking into account changes in the stance of monetary policy in conjunction with changes in financial sector uncertainty. Using a very large data set covering all banks in the US between 1979–2000, we show that financial sector uncertainty plays an important role in banks' lending decisions: overall, small banks tend to lend more than large banks in times of higher uncertainty, as do less liquid banks in comparison to more liquid banks across the same size classification. We also provide evidence that the bank lending channel is either not very important or nonexistent for the US.

JEL: E44, E52, G32.

1 Introduction

Understanding the role of banks in the transmission mechanism of monetary policy is essential in explaining the effects of a policy change on the aggregate economy. In seeking to evaluate the effects of monetary policy, research using bank– and firm–level data has unearthed considerable evidence that the impact of changes in monetary policy may go beyond the simple textbook interest rate channel. In particular, Kashyap and Stein (2000, hereafter KS) used the Federal Reserve System's Commercial Bank and Bank Holding Company database to study the impact of monetary policy on bank lending behavior for banks with differing degrees of liquidity, focusing on the period between 1976–1993. KS have shown that smaller and less liquid banks would reduce their loan supply in response to contractionary monetary policy as their ability to raise *reservable* forms of financing is compromised. As KS point out, another reason for small banks' curtailment of loans is that these banks cannot sell *non–reservable* liabilities due to a failure of the Modigliani–Miller proposition. These changes in bank lending behavior, particularly affecting bank–dependent borrowers, would have important implications for firms' financing behavior, as their impact is over and above the effects of changes in interest rates.

In this paper, we re–examine the impact of changes in monetary policy on bank lending behavior by incorporating financial sector uncertainty into the KS framework. We argue that banks' lending decision depends not only on the stance of monetary policy, but will generally be affected by the underlying uncertainty in the financial sector.[1] Profit–maximising banks will make decisions to extend loans to present or potential customers based on the current stance of monetary policy as well as on the uncertainty in the financial sector, over and above the constraints posed by regulatory authorities and borrowers' creditworthiness.[2] In that sense, current empirical models that investigate the transmission mechanism of monetary policy may be considered as misspecified, and the exclusion of relevant explanatory variables will

[1] Baum, Caglayan and Ozkan (2002) investigate the impact of macroeconomic uncertainty on the cross sectional distribution of bank lending behavior. They find evidence that during more uncertain times, banks behave more homogeneously, as captured by a narrowing of the cross–sectional distribution of their loan–to–asset ratio. However, their study does not indicate how the level of bank lending activity may change as uncertainty evolves over time.

[2] Use of the term uncertainty henceforth implies financial sector uncertainty.

lead to biased conclusions.

To achieve our goal, following KS' strategy, we use the Federal Reserve System's Commercial Bank and Bank Holding Company (henceforth BHC) database which contains information on all banks regulated by the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Comptroller of the Currency. Our extract of this data set covers essentially all banks in the U.S. on a quarterly basis from 1979–2000, with 9,000–16,000 observations per quarter.

Our analysis proceeds as follows. After carefully constructing variables as suggested in KS to eliminate potential definitional discrepancies, we estimate the KS model to see if the choice of sample period that we employ in our analysis qualitatively alters their findings. Next, we focus on the impact of uncertainty on bank lending behavior by employing a number of interest rates and interest rate spreads to generate uncertainty measures from daily data, using a method originally proposed by Merton (1980).[3] Using these measures of financial sector uncertainty, we test whether uncertainty has a significant effect on bank lending behavior for small, intermediate and large banks with different degrees of balance sheet strength.[4]

Our main findings can be summarized as follows: we find that the degree of uncertainty has significant effects on bank lending behavior not only on its own (the primary effect) but also through its interaction with the strength of banks' balance sheets (the secondary effect). We show that the primary effect is positive and increasing in bank size. We also find that the sensitivity of bank lending behavior to balance sheet strength declines as the degree of uncertainty increases. In this context, within each bank size classification, weaker banks (banks with less liquid assets) tend to increase their lending activity during times of higher uncertainty in comparison to stronger banks (banks with more liquid assets), possibly lending to more risky projects. Considering the primary and secondary effects simultaneously, although increased uncertainty leads to an increase in overall lending behavior, we find that small banks increase their lending more than do larger banks. These results are robust across all uncertainty proxies and bank loan types: total

[3]Our measures of uncertainty captures the interaction of what the Federal Reserve does (and might do) with other sources of uncertainty emanating from the financial sector, and possibly from the real sector. Hence, it would not be accurate to consider it merely as representing monetary policy uncertainty.

[4]We use several different series to generate measures of uncertainty proxies so that we could demonstrate that our results are not driven by our choice of proxy.

loans or commercial and industrial (C&I) loans. However, when we sift the evidence in search for a bank lending channel, we find mixed support. Although our broader model confirms the existence of the bank lending channel when we examine total loans, its economic importance may not be as significant as KS claim: at least a quarter—and up to a half—of the small banks behave more like the intermediate banks, with a sensitivity to monetary policy quite dissimilar to their smaller counterparts. In addition, support for the lending view completely disappears when we investigate the behavior of C&I loans: C&I lending behavior of small and large banks seems to be quite similar in response to changes in the stance of monetary policy.

The rest of the paper is constructed as follows. Section 2 provides a brief survey of the literature discussing the bank lending channel. Section 3 presents the modeling framework and discusses the methodology we employ in our investigation. Section 4 documents our empirical findings, while Section 5 concludes and draws implications for future research.

2 The Bank Lending Channel

There is now a substantial body of theoretical and empirical literature indicating that monetary policy affects the economy beyond the well known interest rate channel. The intuition for the primary impact of monetary policy, via the interest rate channel, is that contractionary monetary policy leads to an increase in real interest rates, causing postponement of consumption and a reduction of investment spending. However, as Bernanke and Gertler (1995) pointed out, the impact of monetary policy on the economy is larger than that implied by the estimates of the interest elasticities of consumption and investment and they suggest that there must be other mechanisms at work. One possibility is that, because contractionary monetary policy decreases the core deposit funding of bank loans through reserve requirements, some banks would reduce their lending activity, as they may be unable to raise nonreservable funds to continue lending due to a failure of the Modigliani–Miller proposition.[5] This view is termed the narrow credit channel or the bank lending channel.

[5]It is also possible that contractionary monetary policy affects the balance sheets of the borrowers, by reducing the value of assets and increasing the interest payments, so that their ability to raise funds from *any* external source is diminished. This is called the broad credit channel.

An earlier study by Bernanke and Blinder (1992) finds that contractionary monetary policy leads to a decline in bank lending activity. Though consistent with the lending view, this study is criticized on the grounds that the use of aggregate data may confound a reduction in the supply of loans with reduced loan demand. Subsequently, Kashyap, Stein and Wilcox (1993, 1996) show that a monetary contraction increases the issuance of commercial paper. This evidence suggests that any reduction in observed lending is not due to a reduction in loan demand, but rather reflects a reduction in loan supply.[6] Also, Calomiris, Himmelberg, and Wachtel (1995) show that during periods of monetary contraction, commercial paper–issuing firms increase trade credit extended by these firms, suggesting that larger firms take up some of the slack created as their smaller customers lose access to bank loans. Along similar lines, Nielsen (2002) concentrates on the use of trade credit by small firms (which is available to all customers, but at penalty rates) and shows that small firms use trade credit more heavily during periods of monetary contraction, supporting the evidence of a bank lending channel.[7]

Turning now to studies on bank lending behavior, Peek and Rosengren (1995) and Stein (1998) point out that poorly capitalized banks and those that carry bad loans on their books, respectively, will suffer reduced access to markets for uninsured funding, and their lending behavior will be more dependent on monetary shocks. A more influential study conducted by Kashyap and Stein (2000) employed the BHC database to find that the impact of monetary policy on bank lending activity is stronger, in particular, for small banks with less liquid balance sheets. Similarly, utilizing the approach developed by KS, researchers using European bank–level data have also begun to provide evidence in support of the bank lending channel. For example, Worms (2001) uses monthly balance sheet data for 1992–1998 covering all German banks to find evidence compatible with the lending view.[8]

[6] Gertler and Gilchrist (1994) show that large firms' bank lending actually increases, while small firms suffer from reductions in the growth rate of bank loans outstanding. Therefore, it could be that reduction in bank loans to small firms could be driven by a lower demand for credit.

[7] Nielsen also finds that larger firms increase their trade credit use and explains this phenomena as an issue of the "flight to quality" as proposed by Bernanke, Gertler and Gilchrist (1996).

[8] See references therein.

3 Assessing the Bank Lending Channel Under Uncertainty

In this study we aim to broaden our understanding of banks' lending behavior due to changes in the stance of monetary policy in conjunction with changes in financial sector uncertainty by extending the basic KS model. In a setting with no uncertainty, it would be sufficient to investigate the impact of key indicators of macroeconomic performance to understand the behavior of economic agents. More realistically, one must be concerned with second moments (uncertainty about the course of the macroeconomy, the volatility of interest rates, or more generally financial sector volatility) along with the first moments. These second–moment effects may be of key relevance to economic policymakers, as they may have a sizable influence on commercial banks' decision making process. Therefore, it is crucial to evaluate the degree to which financial sector uncertainty will affect banks' willingness to utilize available loanable funds. However, the existing literature containing a variety of evidence in support of the bank lending channel has not considered the impact of uncertainty. In this paper, we seek to demonstrate that uncertainty has important effects on bank lending behavior, and that a model of the transmission mechanism of monetary policy which ignores the primary and secondary effects of uncertainty could be seriously misspecified in their absence.[9]

KS follow two different appproaches, labelled as the two–step model and the one–step model. Since they find that the two–step approach "probably errs on the side of being overparameterized" (2000, p. 421), we will focus on their one–step approach. Their standard *univariate* one–step model is:

$$\begin{aligned}\Delta log(L_{it}) = \sum_{j=1}^{4} \alpha_j \Delta log(L_{it-j}) + \sum_{j=0}^{4} \mu_j \Delta M_{t-j} + \Theta TIME_t + \\ \sum_{k=1}^{3} \rho_k QUARTER_{kt} + \sum_{k=1}^{12} \Psi_k FRB_{ik} + \\ B_{it-1}\left(\eta + \delta TIME_t + \sum_{j=0}^{4} \phi_j \Delta M_{t-j}\right) + \epsilon_{it},\end{aligned} \quad (1)$$

where L_{it} is a bank-level measure of lending activity, B_{it} is a measure of

[9]The models employed in many of the bank–level empirical studies that have followed in KS' footsteps are subject to the same criticism.

balance sheet strength, and M_t is a monetary policy indicator. Time effects are captured by $TIME_t$ and $QUARTER_{kt}$ dummies and FRB_{ik} captures geographical effects via Federal Reserve district dummies. KS also consider the following version of their model:

$$\begin{aligned}\Delta log(L_{it}) = \sum_{j=1}^{4} \alpha_j \Delta log(L_{it-j}) + \sum_{j=0}^{4} \mu_j \Delta M_{t-j} + \sum_{j=0}^{4} \pi_j \Delta GDP_{t-j} + \\ \Theta TIME_t + \sum_{k=1}^{3} \rho_k QUARTER_{kt} + \sum_{k=1}^{12} \Psi_k FRB_{ik} + \\ B_{it-1}\left(\eta + \delta TIME_t + \sum_{j=0}^{4} \phi_j \Delta M_{t-j} + \sum_{j=0}^{4} \gamma_j \Delta GDP_{t-j}\right) + \epsilon_{it},\end{aligned} \quad (2)$$

and term it the *bivariate* specification, differing from the univariate model by the introduction of GDP_t to control for changes in overall economic activity.

In both of these models, KS are interested in the coefficient of ΔM_{t-j} interacted with B_{it-1}. Intuitively, the less liquid bank will reduce its loans if its lost insured deposits due to a contractionary monetary shock cannot be replenished by other forms of finance. Hence, one would expect to see $\partial^2 L_{it}/\partial B_{it} \partial M_t < 0$ for less liquid banks. To test this hypothesis, they focus on how small and large banks differ from each other in their ability to raise uninsured forms of financing, without frictions. KS claim that $\partial^3 L_{it}/\partial B_{it} \partial M_t \partial SIZE_{it} > 0$ is an effect of size. The sign of the third derivative can be interpreted as implying that the effect of contractionary monetary policy will be strongest for the smallest banks, while the largest banks will be less sensitive, since they have better access to the market for uninsured funds.

Nevertheless, these approaches fail to take into account the fact that loans to private borrowers exhibit both market risk and default risk, with the latter risk correlated, in many cases, with macroeconomic conditions, as well as to financial–market outcomes such as movements in the cost of short–term funds.[10] In that sense, we argue that the KS model omits an important variable: financial sector uncertainty. Such an omission will lead to biased and inconsistent estimates of the model's parameters, and in particular of the

[10] A simple portfolio optimization model, in which the bank manager must rebalance her asset portfolio to maintain an appropriate level of risk and expected return, would imply that a bank would be expected to reduce its exposure to risky loans in the face of greater perceived uncertainty, and the resulting likelihood of borrowers' default.

effects of monetary policy on banks' behavior. To overcome this problem, we develop the following modified *univariate* and *bivariate* models:

$$\Delta log(L_{it}) = \sum_{j=1}^{4} \alpha_j \Delta log(L_{it-j}) + \sum_{j=0}^{4} \mu_j \Delta M_{t-j} + \sum_{j=0}^{4} \lambda_j \sigma(M)_{t-j} + \Theta TIME_t + \sum_{k=1}^{3} \rho_k QUARTER_{kt} + \sum_{k=1}^{12} \Psi_k FRB_{ik} + B_{it-1} \left(\eta + \delta TIME_t + \sum_{j=0}^{4} \phi_j \Delta M_{t-j} + \sum_{j=0}^{4} \xi_j \sigma(M)_{t-j} \right) + \epsilon_{it}, \tag{3}$$

$$\Delta log(L_{it}) = \sum_{j=1}^{4} \alpha_j \Delta log(L_{it-j}) + \sum_{j=0}^{4} \mu_j \Delta M_{t-j} + \sum_{j=0}^{4} \pi_j \Delta GDP_{t-j} + \sum_{j=0}^{4} \lambda_j \sigma(M)_{t-j} + \Theta TIME_t + \sum_{k=1}^{3} \rho_k QUARTER_{kt} + \sum_{k=1}^{12} \Psi_k FRB_{ik} + B_{it-1} \left(\eta + \delta TIME_t + \sum_{j=0}^{4} \phi_j \Delta M_{t-j} + \sum_{j=0}^{4} \gamma_j \Delta GDP_{t-j} + \sum_{j=0}^{4} \xi_j \sigma(M)_{t-j} \right) + \epsilon_{it}, \tag{4}$$

In these specifications, a proxy for financial sector uncertainty, $\sigma(M)_t$, is integrated into the simple KS approach. Note that $\sigma(M)_t$ appears both by itself and in conjunction with a measure of balance sheet strength, B_t. The latter interaction term allows us to evaluate whether the effect of uncertainty on bank lending behavior differs with respect to the bank's liquidity, whereas the former term captures the direct effect of uncertainty. We also investigate the impact of size effects on this relationship. Furthermore, by employing this specification, we can determine whether KS' results are biased; significant coefficients on the $\sigma(M)_t$ terms would imply that uncertainty has been mistakenly omitted from their specification.

3.1 Identifying Financial Sector Uncertainty

Any attempt to evaluate the effects of uncertainty $\sigma(M)_t$ on the bank lending behavior requires specification of a measure of risk. In this study, we utilize several different series derived from daily interest rates to generate measures of monetary policy volatility. This approach allows us to check the robustness of our results and examine whether our results are driven by the choice of a specific uncertainty proxy. The series we employ to generate a measure of uncertainty include both levels and spreads of daily interest rates from Treasury and private markets, accessed from the DRI–Global Insight Basic Economics database. The levels include the rates on Federal funds, three–month Treasury bills, one–year, five–year and ten–year Treasury constant maturity series, and three–month commercial paper. Three term spreads are considered: one–year Treasury versus Federal funds, five–year Treasury versus three-month bill, and ten–year versus one–year Treasury rates. In addition, we consider a risk spread: three–month commercial paper versus the three–month Treasury bill. Below we describe how we generated a monetary policy uncertainty measure from each of these series.

3.1.1 Generating volatility measures from daily data

A number of competing approaches for the construction of volatility measures may be found in the empirical literature. The choice of a particular specification to generate uncertainty may have a considerable impact on the empirical findings, since counterintuitive results may be merely reflecting errors of measurement in a proxy for risk. It is possible to employ a simple moving standard deviation of the policy series, at the same frequency as the data: for instance, including the past four or eight quarters' of changes in the context of quarterly data. However, this measure gives rise to substantial serial correlation in the summary measure. A more sophisticated approach utilises the ability of GARCH models to mimic the "volatility clustering" often found in high-frequency financial series. However, a GARCH model fitted to monthly or quarterly data may find very weak persistence of shocks.

In this study we use (squared) daily changes in the series to capture that quarter's volatility, following a procedure originally proposed by Merton (1980) to better represent the uncertainty facing economic agents. In order to employ the Merton methodology to the problem at hand, we must evaluate the intra-quarterly volatility of the series from daily data. We first take the squared first difference of that measure (after dividing by the square root of the number of days intervening), which we then defined as the daily contribution to quarterly volatility:

$$\varsigma_t^d = \left(100\frac{\Delta x_t}{\sqrt{\Delta\phi_t}}\right)^2, \qquad (5)$$

where the denominator expresses the effect of calendar time elapsing between observations on the x process. If data were available every calendar day, $\Delta\phi_t = 1, \forall t$, but given that data are not available on weekends and holidays, $\Delta\phi_t \in (1, 5)$. The estimated quarterly volatility of the monetary policy series is defined as $\Phi_t [x_t] = \sqrt{\sum_{t=1}^{T} \varsigma_t^d}$ where the time index for $\sigma_t [x_t]$ is at the quarterly frequency.[11]

3.2 Identifying Monetary Policy Stance

In the context of our study, it is essential to accurately evaluate the stance of monetary policy. A simple approach is to keep track of the changes in the stock of money, but this may be misleading, as the Federal Reserve aims at smoothing short–term interest rates. The problems with this simple approach have led researchers to develop alternative methods for identifying the stance of policy. Although no clear consensus has emerged, some approaches have been highlighted in the recent literature. We have chosen to employ one of the methods used in KS' work, the method developed by Bernanke and Mihov (1998), to measure the overall stance of U.S. monetary policy via a flexible VAR. We construct the VAR system as described in Bernanke–Mihov's work and compute the stance of monetary policy over the extended span of our BHC data.[12]

4 Empirical findings

4.1 Data

We utilize the Federal Reserve System's Commercial Bank and Bank Holding Company database, covering essentially all banks in the U.S. on a quarterly basis from 1979–2000. We would note that the degree of concentration in the U.S. banking industry—increasing considerably over the period we study—implies that a very large fraction of the observations in the "all banks" data

[11]See Baum, Caglayan and Ozkan (2004) for a more detailed discussion of the procedure along with its merits, and an application on the link between exchange rate volatility and international trade.

[12]Comparison of our computed Bernanke–Mihov measure over the longer sample and that published in their article (which ends in 1997) indicates that the two series are similar.

set are associated with quite small, local institutions.[13] Using this data set we construct our key variables following the recommendation provided in KS' appendix to ensure consistency and eliminate any potential definitional discrepancies.[14]

We provide basic descriptive statistics on our variables in Table 1. The number of observations referenced is the number of bank–quarters in the panel. The first several lines, labeled as interest rates or spreads, are our constructed measures of uncertainty ($\sigma(M)_t$), while Δmbm_t represents the Bernanke–Mihov measure of the stance of monetary policy. The dependent variable in our model is the growth rate of total loans or commercial and industrial (C&I) loans, for which considerably fewer observations are available. Finally, the B_t variable measures the strength of a bank's balance sheet. The following panels of Table 1 present the bank–specific variables for the small, intermediate, and large size categories, respectively, for both total loans and C&I loans. The thresholds for these definitions are the 95th and 99th percentile of total assets, evaluated each quarter; thus a particular bank may appear in different categories over time.

It may be noted that the small banks (in terms of average or median values) have the most liquid balance sheet, with large banks having just over half as large a value for B. Conversely, small banks have the lowest growth rate of loans. This observation holds whether we concentrate on the behavior of total loans (approximately one million observations) or that of C&I loans (approximately 500,000 observations). That is, the the growth rates of both total loans and C&I loans, on average, are greater for large banks than they are for intermediate and small banks.

In the following subsections, we present our results. We first consider the univariate and bivariate KS models over our lengthier sample. We then integrate financial sector uncertainty into their original specification and investigate its impact on bank lending behavior for small, medium and large banks. All analyses were performed for each of the ten volatility series described above. For brevity, we present results for four of those cases: the three–month Treasury bill, the five–year Treasury note, the risk spread (CP

[13]There were over 15,000 banks required to file condition reports in the late 1970s. By 2000Q4, the number of reporting banks fell to 9,261.

[14]We carry out our analysis on the level of the individual bank throughout this paper. We do not aggregate the balance sheets of banks into their holding companies. In their analysis, KS did not find any significant differences in the analysis of individual banks versus the analysis of bank holding company balance sheets.

over TB) and the ten year–one year Treasury term spread.

4.2 Replicating the KS model

We start our investigation by replicating the KS analysis using our longer data set and examine whether changes in monetary policy have an effect on the sensitivity of lending activity to balance sheet strength, $\partial^2 L_{it}/\partial B_{it}\partial M_t$, for *small*, *intermediate* and *large* size classes. Hence, similar to KS, we create small, intermediate and large size classes based on banks' total asset distribution. Small banks are those whose total assets are less than the 95th percentile; intermediate banks' assets range between the 95th percentile and the 99th percentile; large banks' assets are above the 99th percentile. Then, we ran the basic *univariate* and the *bivariate* models given in equations (1) and (2).

To discuss our findings and be able to compare them with that of KS, for each model, we compute the sum of the ϕ coefficients on the monetary policy indicator (labeled $B \cdot MPI$), and also present the effects of changes in GDP captured through the sum of the γ in the bivariate specification for each size category (labeled $B \cdot GDP$).[15] Tables 2 and 3, respectively, give the results for total and C&I loans using the standard KS approach. In comparison to those results presented in KS (2000, Table 5, Panel B, p. 422), results for total loans depicted in Table 2 show that the summary measure for ϕ is significantly negative for small banks in both specifications.[16] Also observe that the coefficient estimate for ϕ becomes larger (in absolute value) when changes in GDP are introduced to control for the state of the economy. While the same coefficient is insignificant for large banks when the univariate model is used, it is positive and significant for the bivariate model. For intermediate banks, we consistently obtain a positive coefficient which is significant under the bivariate model. The results for C&I loans are similar to those for total loans. The coefficient estimates for ϕ are negative and significant for small banks in both specifications. Coefficients for intermediate and large banks are insignificant for univariate (both negative) and bivariate (both positive) specifications. Overall, both sets of results confirm and support the existence

[15] Recall that we measure the stance of monetary policy using only the Bernanke–Mihov approach, and compare our results with those corresponding in KS.

[16] Note that the KS coefficient estimate of ϕ for total loans is insignificant for the bivariate model.

of the bank lending channel for our extended sample, although the estimates of ϕ are smaller than those reported in KS' Table 5.

4.3 The modified KS model: Investigating the effects of uncertainty

Our next set of results utilizes equations (3) and (4) in which we incorporate the effect of uncertainty for each size class. In particular, we examine whether uncertainty has an impact on bank lending behavior and also whether this impact changes depending on banks' balance sheet strength, $\partial L_{it}/\partial\sigma(M)_t$ and $\partial^2 L_{it}/\partial B_{it}\partial\sigma(M)_t$, using the same size classifications. Addition of these new variables into the standard KS model is essential to broaden our understanding on the banks' role in the transmission of monetary policy, since economic agents hardly ignore the impact of uncertainty in their decision–making process. Furthermore, omission of these second–moment effects may lead to erroneous conclusions due to model misspecification. In the subsections below we will initially concentrate on the behavior of total loans and then turn to that of C&I loans.

4.3.1 The extended univariate specification for total loans

In Table 4, we present our results for the modified univariate model, equation (3), which uses the growth of total loans as the dependent variable and employs four different measures of uncertainty, respectively based on the three–month Treasury bill, the five–year Treasury note, the risk spread (CP over TB) and the ten year–one year Treasury term spread.[17] The table lays out the sum of the ϕ coefficients on the monetary policy indicator (labeled $B \cdot MPI$) in conjunction with the bank's balance sheet strength, the sum of λ on uncertainty, $\sigma(M)_t$ (labeled σ), and the sum of ξ on uncertainty in conjunction with bank balance sheet strength $B_{it}\sigma(M)_t$ (labeled $B\cdot\sigma$), for all size categories. For each uncertainty measure and size category, inspection of estimates for ϕ reveals that the coefficients' signs and their magnitudes are similar, albeit generally smaller, than those presented in Table 2. Hence, these results provide support for the bank lending channel. The smaller (absolute) magnitudes of the ϕ coefficients may indicate that the corresponding

[17] Results obtained using the other six volatility series are qualitatively similar to those presented here, and are available upon request from the authors.

estimates in Table 2 are biased upward due to the omission of the effects of uncertainty.

Next, we turn our attention to understanding the relationship between bank lending and financial sector uncertainty, and investigate the remaining sets of coefficients: the sum of λ estimates (labeled σ) and the sum of ξ estimates (labeled $B \cdot \sigma$). The sum of λ estimates on uncertainty is significant and positive for all size groups, irrespective of the uncertainty measure used, with its magnitude monotonically increasing as bank size increases. This result suggests that during times of greater uncertainty larger banks can lend more in comparison to smaller banks, as captured by the sum λ. However, the story does not end here. Uncertainty can also affect banks' lending behavior through its interaction with the strength of the bank balance sheet. We find that the sign of the derivative $\partial^2 L_{it}/\partial B_{it}\partial\sigma(M)_t$ is negative, which implies that the sensitivity of bank lending to balance sheet strength is negatively related to an increase in uncertainty. In other words, as uncertainty increases, banks with less liquid assets (weaker banks) tend to reduce their loans, but by a lesser amount than do banks with more liquid assets (stronger banks). This clearly implies greater risk–taking behavior by banks with weak balance sheets. The monotonic behavior of the same coefficient across size groups indicates that larger banks react more to an increase in uncertainty by reducing their loans. Obviously, the overall impact of uncertainty on bank lending will be related to the sums of λ and ξ estimates, and the long–run effect will depend on all of these coefficients for a given degree of balance sheet strength. We will explain in detail the total long–run effect of uncertainty in the following sections.

4.3.2 Results based on a finer classification for total loans

Given our findings for total loans in Table 4, we further split small banks into subgroups to see whether or not the relationship we have so far portrayed holds for a finer classification. To that end we break up *small* banks into four subgroups: the smallest group ($small_0$) contains banks with total assets below the 25th percentile, the next group ($small_1$) includes banks from the 25th to the 50th percentile, the third group ($small_2$) encompasses banks between the 50th and the 75th percentile, and the largest group ($small_3$) contains those banks above the 75th percentile. We ran equation (3) using this new classification, for which results are presented in Table 5.

A quick glance at the table yields the basic message that the impact of uncertainty, as summarized in the sums of λ and ξ estimates, is also monotonic across subgroups of small banks. Furthermore, the estimated sum of ϕ is negative, implying the existence of the bank lending channel when we use growth in total loans as the dependent variable. A more closer investigation of the table, though, reveals that the distinction between small and intermediate banks may be somewhat misleading. For instance, considering the sum of the coefficient estimates for ϕ, we may note that banks in the $small_3$ subgroup—comprising 20% of the population—seem to behave quite similarly to those in the intermediate group presented in Table 4. Hence, although the bank lending channel is present for total loans, its economic significance may not be as strong as KS have argued, even though their claims are based on 'the most conservative coefficient estimates' (2000, p. 422). Turning now to the impact of uncertainty on lending behavior, we note that the estimates of ξ are insignificant for the $small_0$ category for all measures of uncertainty. This observation indicates that banks within the $small_0$ subgroup will react differently in their lending behavior from those in the other subgroups to a change in uncertainty.

In Table 6, we provide the total long–run effects of uncertainty on lending behavior for each size category. Note that these tables are constructed using the information given in Tables 4 and 5 when the the measure of uncertainty is based on the three–month Treasury bill.[18] The first three columns of Table 6 report the 25th, 50th and 75th percentiles of bank' balance sheet strength (liquidity) across all size categories. The next three columns lay out the total long–run sensitivity of lending behavior to bank strength with respect to changes in uncertainty. For example, we compute $Total[\sigma|B_{p25}] = \sum_{j=0}^{4} \lambda_j + B_{p25} \cdot \left(\sum_{j=0}^{4} \xi_j\right)$ where B_{p25} is the level of banks' balance sheet strength measured at the 25th percentile, and the sums of λ and ξ estimates are those presented in Tables 4 and 5, within each subgroup. All other entries are computed similarly.

Given this background, we can now interpret our results. Let us first consider the information in the rows of these tables. Reading across a row, $\sum_{j=0}^{4} \lambda_j$ is constant within each size group, so that each row is simply capturing the effect of the interaction term, $\partial^2 L_{it}/\partial B_{it}\partial\sigma(M)_t$, evaluated at differing levels of B. Recall that the sign of this term is negative for all classes, except for $small_0$, meaning that an increase in uncertainty reduces the sensitivity of lending to bank strength. In other words, an increase in

[18]Use of other measures of uncertainty produces similar observations.

$\sigma(M)_t$ will lead to a reduction in bank lending as B increases, except for banks in the $small_0$ class. That is exactly what we observe in Table 6. In the case of the smallest group, the opposite phenomena is portrayed; the smallest banks increase their lending activity under uncertainty only if their balance sheet strengthens. The implication of this finding is that within each size group, banks with weaker balance sheets lend more during times of higher uncertainty, taking on more risk. This result is quite understandable from the theory of real options, in the presence of deposit insurance: the option to take a larger gamble becomes more valuable in the face of greater underlying uncertainty.

We can also read the table from top to bottom, noting that several factors change simultaneously as we move down a column from one class of banks to the next. Both $\sum_{j=0}^{4} \lambda_j$ and $\sum_{j=0}^{4} \xi_j$ are changing across classes, as are the levels of B (note from the first three columns that B declines as the bank size increases). In such circumstances, it is possible to obtain any kind of ordering for lending behavior amongst bank classes. Even then, Table 6 presents us with a remarkable observation: the total effect of uncertainty on bank lending behavior is generally declining as we move from the $small_0$ to *intermediate* classes. Furthermore, moving from the first entry of $small_0$ banks to the last entry for *large* banks, the effect of uncertainty on lending drops from 0.0098 to 0.0029. This observation implies that smaller banks tend to lend more in times of uncertainty in comparison to their larger counterparts, taking on more risk in the process. It is possible that since large banks' more sizable loan portfolios allow for diversification, small banks' risk profile may be higher than that of large banks, as the small banks may make more fewer, more geographically–concentrated loans. Hence, our results may reflect the fact that prudently–managed large banks lend on average to less risky borrowers than do their smaller counterparts.

4.3.3 The extended bivariate specification for total loans

As a next step, we present our bivariate regression results for *small*, *intermediate* and *large* bank classes and subgroups for the small banks in tables 7 and 8, respectively. Overall, results from both tables support our findings depicted in tables 4 and 5. Inspecting Table 7, we see that ϕ is negative and significant for *small* banks, positive and significant for *intermediate* banks and positive, but insignificant, for *large* banks. Furthermore, estimates in Table 8 show that the sign of ϕ for $small_0$ and $small_1$ are consistently negative. However, there is now a stronger case for the $small_3$ category—those between the 75th and 95th percentile of the size distribution—to be included in the intermediate group, given the similarity of their behavior. In a similar line of argument, now it appears that one may want to include banks in the $small_2$ category (i.e., all those above the median level of total assets) into the *intermediate* class.

Overall we can argue that there is evidence in favor of the bank lending channel, although its economic significance may not be nearly as large as KS proposed. KS state that the sensitivity of lending behavior to monetary policy is clearly affected by balance sheet strength, and that this "result is largely driven by the smaller banks, those in the bottom 95 percent of the size distribution." (2000, p. 407). Our disaggregation of the size distribution reveals that many of these 'smaller' banks are by no means homogeneous in their sensitivity to monetary policy shocks. Evidence for strong and consistent effects of financial sector uncertainty is also apparent: the monotonic relationship still exists, and the signs and magnitudes of the estimated coefficients are qualitatively similar to those in Tables 4 and 5.

In Table 9, we provide the long–run effects of uncertainty on total loans similar to that in Table 6. Comparing Table 9 with Table 6, we obtain similar conclusions, confirming our previous findings: small banks tend to lend more than large banks in times of heightened uncertainty, as do less–liquid banks in comparison to more–liquid banks across the same size classification (with the exception of banks in the $small_0$ size category).

4.3.4 The extended bivariate specification for C&I loans

Due to space considerations, we will only concentrate on estimates obtained from the bivariate specification for C&I loans. Table 10 presents those results.[19] Interestingly, we find no evidence in support of the bank lending channel. Inspecting the sum of ϕ estimates, we see that it is no longer negative for small banks. It turns out that the sign of ϕ for all categories is now positive and insignificant, refuting the existence of a bank lending channel. This result is very surprising and signals that earlier research searching for a bank lending channel is subject to a severe model misspecification due to omission of these second–moment effects.

[19]Results from the univariate specification are very similar to that of the bivariate model and available upon request from the authors.

Next we concentrate our attention on the relationship between banks' C&I loan activity and financial sector uncertainty. Evidence for strong and consistent effects of financial sector uncertainty is apparent. The sum of λ on uncertainty is significant and positive for all size groups, irrespective of the uncertainty measure used. Furthermore, the sum of the coefficients of ξ, is negative for all size groups. For both sets of coefficients we see a monotonic behavior similar as in the total loans case.

4.3.5 Results based on a finer classification for C&I loans

We carry out our analysis for C&I loans using a finer classification for small banks to be consistent with our earlier approach. Overall, findings presented in Table 11 provide no surprises. The coefficient estimate for the sum of ϕ, similar to the earlier case, is either insignificant or, in some cases, positive and significant, refuting the existence of a bank lending channel. As we turn to evidence in search of effects of uncertainty, we find that the sum of λ estimates and the sum of ξ estimates are significant and we can still observe a monotonic progression as we move from $small_0$ to $small_3$ similar to that for total loans.

Finally, Table 12 provide the total long–run effect of uncertainty on lending behavior. When we read Table 12 for each size classification across rows, we see once again that banks with weaker balance sheets lend more compared to those with stronger balance sheets during times of higher uncertainty. Alternatively, when we inspect the table from top to bottom, we observe that the total effect of uncertainty is generally declining as we move from $small_0$ to *intermediate* banks. In particular, moving from the first entry of $small_0$ banks to the last entry for *intermediate* banks, the effect of uncertainty on lending drops from 0.0426 to 0.0190.[20] Overall, the results in this table clearly demonstrate that smaller banks tend to extend more C&I loans in times of uncertainty than larger banks, as do weaker banks in comparison to their stronger counterparts, taking on more risk in the process.

[20] Also note that the last entry for *large* banks, 0.0348, is smaller than that of the first entry of *small* banks, although the effect for large banks does not drop as much as it does in the case of total loans.

5 Conclusions

In this paper we re–examine the effects of changes in the stance of monetary policy on banks' lending activities by incorporating the impact of financial sector uncertainty. Similar to Kashyap and Stein, we concentrate on the growth rates of total loans and commercial and industrial loans for various size categories. To carry out our investigation, we use the Federal Reserve System's Commercial Bank and Bank Holding Company database which contains information on all banks regulated by the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Comptroller of the Currency. Our data set covers the period between 1979–2000 on a quarterly basis, with 9,000–16,000 observations per quarter.

Using our longer data set, we first confirm the existence of the bank lending channel for both total and commercial and industrial loans running standard specifications used by Kashyap and Stein. We then extend the model by incorporating the effects of financial sector uncertainty. Using this broader model, we show that overall uncertainty has a positive impact on lending activities across all bank classifications. Furthermore, we find that smaller banks increase their lending more than larger banks, and that weaker banks (banks with less–liquid assets) tend to lend more than stronger banks (banks with more–liquid assets) during times of higher uncertainty. These results are robust to use of different measures of uncertainty.

Our analysis reveals further surprising results. We show that earlier research searching for a bank lending channel is subject to model misspecification: researchers may have arrived at erroneous conclusions due to omission of these second–moment effects, whose importance is evident in our estimates. The estimated sensitivity of bank lending to monetary policy shocks—the sum of ϕ coefficients–changes considerably when uncertainty is taken into account, suggesting that prior estimates may be biased.

Our empirical evidence leads us to believe that although the behavior of banks' total loan activity provides support for a bank lending channel, its economic significance may not be as large as previously claimed, since at least a quarter—and up to a half—of the small banks behave more like the intermediate banks, with a sensitivity to monetary policy quite dissimilar to their smaller counterparts. Furthermore, when we turn our attention to C&I loans, we can find no evidence in favor of a bank lending channel: the effects of balance sheet strength and the stance of monetary policy on lending behavior no longer varies across bank size categories. This finding contradicts the basic intuition of the bank lending view that small, weak banks lacking access to the market for non–reservable funds should reduce their lending more than their stronger counterparts during episodes of monetary contraction. Overall, our findings call for more empirical research, for example using European data to see whether financial sector uncertainty has any effect on bank lending, and consider whether the bank lending channel indeed exists.

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Table 1: Descriptive statistics

	N	μ	σ	$p25$	$p50$	$p75$
3-month TBill		70.1770	63.0378	32.3116	46.1210	72.3064
5-year Treasury		61.6596	30.7729	40.8401	49.3423	67.9509
CP-TB spread		78.0399	76.5679	34.4634	46.6486	74.5969
10 yr–1 yr Treas. spread		44.5795	29.3139	27.1155	33.4489	47.5641
Δmbm		0.0006	0.0283	-0.0105	-0.0004	0.0071
(A) Total Loans						
All banks						
$\Delta \log totloans$	1,087,683	0.0239	0.0877	-0.0126	0.0175	0.0501
B		0.3317	0.1523	0.2249	0.3181	0.4272
Small banks						
$\Delta \log totloans$	1,041,487	0.0238	0.0866	-0.0127	0.0174	0.0501
B		0.3359	0.1516	0.2294	0.3224	0.4313
Intermediate banks						
$\Delta \log totloans$	36,707	0.0270	0.1107	-0.0096	0.0187	0.0496
B		0.2498	0.1412	0.1616	0.2405	0.3255
Large banks						
$\Delta \log totloans$	9,489	0.0303	0.1032	-0.0089	0.0206	0.0527
B		0.1880	0.1007	0.1170	0.1813	0.2444
(B) Commercial and Industrial Loans						
All banks						
$\Delta \log C\&Iloans$	498,353	0.0261	0.1913	-0.0468	0.0176	0.0899
B		0.3228	0.1401	0.2278	0.3115	0.4079
Small banks						
$\Delta \log C\&Iloans$	476,472	0.0259	0.1934	-0.0482	0.0173	0.0910
B		0.3267	0.1398	0.2319	0.3153	0.4118
Intermediate banks						
$\Delta \log C\&Iloans$	17,231	0.0291	0.1422	-0.0258	0.0206	0.0722
B		0.2510	0.1173	0.1773	0.2480	0.3228
Large banks						
$\Delta \log C\&Iloans$	4,560	0.0326	0.1205	-0.0196	0.0241	0.0681
B		0.1846	0.0920	0.1178	0.1728	0.2374

Note: N refers to the number of bank–quarters in the category. $p25$, $p50$ and $p75$ represent the quartiles of the distribution of each variable, while μ and σ are the mean and standard deviation.

Table 2: One–step estimates for total loans: sums of coefficients on monetary policy indicator and GDP growth

	Univariate	*Bivariate*	
Size [N]	$B \cdot MPI$	$B \cdot MPI$	$B \cdot GDP$
Small ($< p95$)	-0.470	-0.516	-0.697
[964,669]	(0.074)	(0.107)	(0.187)
Intermediate ($p95 - p99$)	0.956	3.231	6.090
[33,603]	(0.716)	(0.980)	(1.735)
Large ($> p99$)	-3.085	0.454	9.445
[8,832]	(1.395)	(1.999)	(3.343)

Note: robust standard errors in parentheses.

Table 3: One–step estimates for C&I loans: sums of coefficients on monetary policy indicator and GDP growth

	Univariate	*Bivariate*	
Size [N]	$B \cdot MPI$	$B \cdot MPI$	$B \cdot GDP$
Small ($< p95$)	-2.018	-0.971	1.949
[398,117]	(0.269)	(0.401)	(0.649)
Intermediate ($p95 - p99$)	-1.184	2.088	6.085
[14,859]	(1.320)	(1.924)	(3.150)
Large ($> p99$)	-2.699	1.674	10.824
[3,979]	(2.170)	(3.644)	(5.495)

Note: robust standard errors in parentheses.

Table 4: One–step estimates, univariate model for total loans: sums of coefficients on monetary policy indicator and uncertainty

σ calculated from	*Size*	$B \cdot MPI$	σ	$B \cdot \sigma$
Three–month	Small	-0.465	0.010	-0.004
Treasury bill	($< p95$)	(0.083)	(0.001)	(0.002)
	Intermediate	0.507	0.016	-0.048
	($p95 - p99$)	(0.777)	(0.004)	(0.015)
	Large	-2.177	0.024	-0.086
	($> p99$)	(1.616)	(0.006)	(0.034)
Five–year	Small	-0.275	0.027	-0.026
Treasury note	($< p95$)	(0.079)	(0.001)	(0.004)
	Intermediate	1.307	0.059	-0.181
	($p95 - p99$)	(0.766)	(0.010)	(0.036)
	Large	-1.414	0.066	-0.201
	($> p99$)	(1.530)	(0.015)	(0.077)
Three month	Small	-0.542	0.007	-0.004
commercial paper–	($< p95$)	(0.081)	(0.000)	(0.001)
Tbill spread	Intermediate	0.712	0.011	-0.037
	($p95 - p99$)	(0.756)	0.003)	(0.012)
	Large	-2.022	0.018	-0.072
	($> p99$)	(1.607)	(0.005)	(0.029)
Ten year–	Small	-0.385	0.020	-0.013
One year	($< p95$)	(0.082)	(0.001)	(0.004)
Treasury spread	Intermediate	1.206	0.037	-0.132
	($p95 - p99$)	(0.785)	(0.010)	(0.033)
	Large	-1.942	0.047	-0.188
	($> p99$)	(1.650)	(0.015)	(0.082)

Note: robust standard errors in parentheses.

Table 5: One–step estimates, univariate model for total loans: sums of coefficients on monetary policy indicator and uncertainty

σ calculated from	*Size*	$B \cdot MPI$	σ	$B \cdot \sigma$
Three–month	Small_0 ($< p25$)	-0.816	0.009	0.004
Treasury bill		(0.158)	(0.001)	(0.003)
	Small_1 ($p25 - p50$)	-0.619	0.011	-0.004
		(0.144)	(0.001)	(0.003)
	Small_2 ($p50 - p75$)	-0.425	0.011	-0.009
		(0.155)	(0.001)	(0.003)
	Small_3 ($p75 - p95$)	-0.022	0.012	-0.020
		(0.227)	(0.002)	(0.005)
Five–year	Small_0 ($< p25$)	-0.570	0.023	-0.007
Treasury note		(0.151)	(0.003)	(0.008)
	Small_1 ($p25 - p50$)	-0.467	0.029	-0.024
		(0.766)	(0.003)	(0.007)
	Small_2 ($p50 - p75$)	-0.283	0.030	-0.037
		(0.149)	(0.003)	(0.007)
	Small_3 ($p75 - p95$)	0.193	0.034	-0.070
		(0.219)	(0.004)	(0.011)
Three month	Small_0 ($< p25$)	-0.837	0.007	0.002
commercial paper–Tbill		(0.154)	(0.001)	(0.003)
spread	Small_1 ($p25 - p50$)	-0.716	0.009	-0.004
		(0.142)	0.001)	(0.002)
	Small_2 ($p50 - p75$)	-0.520	0.009	-0.008
		(0.150)	(0.001)	(0.002)
	Small_3 ($p75 - p95$)	-0.141	0.009	-0.016
		(0.220)	(0.001)	(0.004)
Ten year–One year	Small_0 ($< p25$)	-0.701	0.019	-0.000
Treasury spread		(0.156)	(0.003)	(0.008)
	Small_1 ($p25 - p50$)	-0.562	0.024	-0.012
		(0.143)	(0.003)	(0.007)
	Small_2 ($p50 - p75$)	-0.362	0.022	-0.021
		(0.152)	(0.002)	(0.007)
	Small_3 ($p75 - p95$)	0.117	0.024	-0.050
		(0.228)	(0.003)	(0.010)

Note: robust standard errors in parentheses.

Table 6: Univariate model for total loans: Total effect of σ for quartiles of B

	B_{p25}	B_{p50}	B_{p75}	$Total[\sigma\|B_{p25}]$	$Total[\sigma\|B_{p50}]$	$Total[\sigma\|B_{p75}]$
small	0.2300	0.3200	0.4300	0.0091	0.0088	0.0084
$small_0$	0.2400	0.3400	0.4600	0.0098	0.0103	0.0108
$small_1$	0.2400	0.3300	0.4400	0.0104	0.0100	0.0096
$small_2$	0.2400	0.3300	0.4300	0.0091	0.0083	0.0074
$small_3$	0.2100	0.2900	0.3800	0.0074	0.0059	0.0041
intermediate	0.1600	0.2400	0.3300	0.0078	0.0040	*0.0000*
large	0.1200	0.1800	0.2400	0.0138	0.0083	*0.0029*

Note: italicized entries are not significantly different from zero at 5%.

Table 7: One–step estimates, bivariate model for total loans: sums of coefficients on monetary policy indicator, GDP growth, and uncertainty

σ calculated from	*Size*	$B \cdot MPI$	$B \cdot GDP$	σ	$B \cdot \sigma$
Three–month	Small	-0.480	-0.989	0.012	-0.005
Treasury bill	($< p95$)	(0.120)	(0.215)	(0.001)	(0.002)
	Intermediate	2.679	5.338	0.018	-0.032
	($p95 - p99$)	(1.063)	(1.923)	(0.005)	(0.016)
	Large	0.860	6.298	0.033	-0.086
	($> p99$)	(2.238)	(3.852)	(0.007)	(0.037)
Five–year	Small	-0.271	-0.711	0.032	-0.025
Treasury note	($< p95$)	(0.111)	(0.199)	(0.002)	(0.004)
	Intermediate	3.293	5.443	0.061	-0.134
	($p95 - p99$)	(1.019)	(1.833)	(0.011)	(0.038)
	Large	1.440	6.604	0.093	-0.231
	($> p99$)	(2.069)	(3.556)	(0.016)	(0.082)
Three month	Small	-0.608	-1.038	0.009	-0.004
commercial paper–	($< p95$)	(0.118)	(0.216)	(0.001)	(0.002)
Tbill spread	Intermediate	2.908	5.488	0.013	-0.023
	($p95 - p99$)	(1.050)	(1.941)	0.004)	(0.013)
	Large	1.369	7.578	0.024	-0.067
	($> p99$)	(2.240)	(3.931)	(0.006)	(0.031)
Ten year–	Small	-0.513	-1.004	0.029	-0.017
One year	($< p95$)	(0.115)	(0.220)	(0.002)	(0.004)
Treasury spread	Intermediate	3.281	5.615	0.043	-0.080
	($p95 - p99$)	(1.036)	(1.986)	(0.011)	(0.037)
	Large	0.695	5.860	0.069	-0.166
	($> p99$)	(2.171)	(4.005)	(0.017)	(0.092)

Note: robust standard errors in parentheses.

Table 8: One–step estimates, bivariate model for total loans: sums of coefficients on monetary policy indicator, GDP growth, and uncertainty

σ calculated from	*Size*	$B \cdot MPI$	$B \cdot GDP$	σ	$B \cdot \sigma$
Three–month	Small_0 ($< p25$)	-0.674	-0.224	0.009	0.005
Treasury bill		(0.220)	(0.396)	(0.001)	(0.004)
	Small_1 ($p25 - p50$)	-0.719	-1.171	0.014	-0.006
		(0.201)	(0.366)	(0.001)	(0.003)
	Small_2 ($p50 - p75$)	-0.436	-0.998	0.014	-0.009
		(0.221)	(0.385)	(0.001)	(0.003)
	Small_3 ($p75 - p95$)	0.539	0.120	0.014	-0.016
		(0.347)	(0.615)	(0.002)	(0.005)
Five–year	Small_0 ($< p25$)	-0.370	0.126	0.024	-0.003
Treasury note		(0.203)	(0.371)	(0.003)	(0.008)
	Small_1 ($p25 - p50$)	-0.531	-0.963	0.034	-0.027
		(0.187)	(0.343)	(0.003)	(0.008)
	Small_2 ($p50 - p75$)	-0.259	-0.699	0.036	-0.036
		(0.203)	(0.357)	(0.003)	(0.008)
	Small_3 ($p75 - p95$)	0.614	0.318	0.039	-0.058
		(0.319)	(0.566)	(0.004)	(0.121)
Three month	Small_0 ($< p25$)	-0.739	-0.200	0.007	-0.003
commercial paper–		(0.216)	(0.397)	(0.001)	(0.003)
Tbill spread	Small_1 ($p25 - p50$)	-0.857	-1.253	0.010	-0.005
		(0.198)	(0.367)	0.001)	(0.013)
	Small_2 ($p50 - p75$)	-0.594	-1.089	0.011	-0.008
		(0.218)	(0.390)	(0.001)	(0.003)
	Small_3 ($p75 - p95$)	0.364	-0.005	0.011	-0.013
		(0.340)	(0.617)	(0.001)	(0.004)
Ten year–	Small_0 ($< p25$)	-0.719	-0.259	0.022	0.000
One year		(0.208)	(0.405)	(0.003)	0.008)
Treasury spread	Small_1 ($p25 - p50$)	-0.778	-1.244	0.032	-0.020
		(0.191)	(0.375)	(0.003)	(0.008)
	Small_2 ($p50 - p75$)	-0.470	-1.003	0.031	-0.024
		(0.210)	(0.395)	(0.003)	(0.008)
	Small_3 ($p75 - p95$)	0.494	0.030	0.034	-0.043
		(0.333)	(0.636)	(0.004)	(0.012)

Note: robust standard errors in parentheses.

Table 9: Bivariate model for total loans: Total effect of σ for quartiles of B

	B_{p25}	B_{p50}	B_{p75}	$Total[\sigma\|B_{p25}]$	$Total[\sigma\|B_{p50}]$	$Total[\sigma\|B_{p75}]$
$small$	0.2300	0.3200	0.4300	0.0112	0.0108	0.0103
$small_0$	0.2400	0.3400	0.4600	0.0104	0.0109	0.0114
$small_1$	0.2400	0.3300	0.4400	0.0121	0.0116	0.0109
$small_2$	0.2400	0.3300	0.4300	0.0116	0.0107	0.0097
$small_3$	0.2100	0.2900	0.3800	0.0108	0.0096	0.0081
$intermediate$	0.1600	0.2400	0.3300	0.0125	0.0100	0.0072
$large$	0.1200	0.1800	0.2400	0.0224	0.0169	0.0115

Table 10: One–step estimates, bivariate model for C&I loans: sums of coefficients on monetary policy indicator, GDP growth, and uncertainty

σ *calculated from*	*Size*	$B \cdot MPI$	$B \cdot GDP$	σ	$B \cdot \sigma$
Three–month	Small	0.748	2.750	0.044	-0.037
Treasury bill	($< p95$)	(0.504)	(0.844)	(0.002)	(0.007)
	Intermediate	2.432	4.272	0.036	-0.053
	($p95 - p99$)	(3.014)	(5.236)	(0.010)	(0.039)
	Large	1.284	6.167	0.054	-0.080
	($> p99$)	(4.651)	(7.818)	(0.012)	(0.057)
Five–year	Small	-0.087	1.985	0.106	-0.096
Treasury note	($< p95$)	(0.442)	(0.786)	(0.005)	(0.016)
	Intermediate	3.517	6.337	0.100	-0.152
	($p95 - p99$)	(2.459)	(4.725)	(0.023)	(0.094)
	Large	1.571	4.337	0.142	-0.262
	($> p99$)	(4.240)	(7.235)	(0.027)	(0.132)
Three month	Small	0.534	2.296	0.033	-0.028
commercial paper–	($< p95$)	(0.491)	(0.832)	(0.002)	(0.006)
Tbill spread	Intermediate	3.033	5.554	0.026	-0.037
	($p95 - p99$)	(2.963)	(5.144)	(0.008)	(0.030)
	Large	1.928	7.437	0.041	-0.057
	($> p99$)	(4.640)	(7.997)	(0.009)	(0.045)
Ten year–	Small	0.470	2.279	0.096	-0.078
One year	($< p95$)	(0.471)	(0.858)	(0.005)	(0.016)
Treasury spread	Intermediate	1.901	4.303	0.080	-0.109
	($p95 - p99$)	(2.799)	(5.311)	(0.022)	(0.093)
	Large	0.852	3.754	0.127	-0.191
	($> p99$)	(4.498)	(8.265)	(0.027)	(0.134)

Note: robust standard errors in parentheses.

Table 11: One–step estimates, bivariate model for C&I loans: sums of coefficients on monetary policy indicator, GDP growth, and uncertainty

σ calculated from	*Size*	$B \cdot MPI$	$B \cdot GDP$	σ	$B \cdot \sigma$
Three–month	Small_0 ($< p25$)	-1.004	0.690	0.054	-0.048
Treasury bill		(1.178)	(1.896)	(0.006)	(0.016)
	Small_1 ($p25 - p50$)	-0.566	-0.382	0.044	-0.032
		(0.903)	(1.517)	(0.004)	(0.013)
	Small_2 ($p50 - p75$)	0.321	3.356	0.042	-0.037
		(0.936)	(1.585)	(0.004)	(0.013)
	Small_3 ($p75 - p95$)	4.400	7.751	0.046	-0.063
		(1.054)	(1.854)	(0.005)	(0.015)
Five–year	Small_0 ($< p25$)	-1.210	1.554	0.119	-0.101
Treasury note		(1.012)	(1.762)	(0.013)	(0.036)
	Small_1 ($p25 - p50$)	-1.293	-1.043	0.099	-0.079
		(0.795)	(1.407)	(0.010)	(0.029)
	Small_2 ($p50 - p75$)	-0.737	2.575	0.104	-0.099
		(0.825)	(1.472)	(0.010)	(0.031)
	Small_3 ($p75 - p95$)	2.701	5.520	0.120	-0.168
		(0.913)	(1.738)	(0.011)	(0.035)
Three month	Small_0 ($< p25$)	-1.135	0.543	0.041	-0.038
commercial paper–		(1.139)	(1.867)	(0.004)	(0.012)
Tbill spread	Small_1 ($p25 - p50$)	-1.032	-1.242	0.034	-0.026
		(0.881)	(1.488)	(0.003)	(0.010)
	Small_2 ($p50 - p75$)	-0.014	2.674	0.032	-0.030
		(0.918)	(1.565)	(0.003)	(0.010)
	Small_3 ($p75 - p95$)	4.295	7.532	0.033	-0.045
		(1.031)	(1.829)	(0.004)	(0.012)
Ten year–	Small_0 ($< p25$)	-1.457	0.537	0.118	-0.104
One year		(1.086)	(1.900)	(0.013)	(0.035)
Treasury spread	Small_1 ($p25 - p50$)	-1.030	-1.190	0.099	-0.075
		(0.847)	(1.527)	(0.010)	(0.029)
	Small_2 ($p50 - p75$)	0.103	2.399	0.092	-0.083
		(0.890)	(1.632)	(0.010)	(0.031)
	Small_3 ($p75 - p95$)	4.057	6.742	0.100	-0.130
		(0.976)	(1.912)	(0.010)	(0.035)

Note: robust standard errors in parentheses.

Table 12: Bivariate model for C&I loans: Total effect of σ for quartiles of B

	B_{p25}	B_{p50}	B_{p75}	$Total[\sigma\|B_{p25}]$	$Total[\sigma\|B_{p50}]$	$Total[\sigma\|B_{p75}]$
$small$	0.2300	0.3200	0.4100	0.0356	0.0325	0.0290
$small_0$	0.2400	0.3400	0.4500	0.0426	0.0382	0.0330
$small_1$	0.2400	0.3200	0.4200	0.0362	0.0335	0.0303
$small_2$	0.2300	0.3100	0.4000	0.0330	0.0300	0.0267
$small_3$	0.2100	0.2900	0.3700	0.0327	0.0279	0.0227
$intermediate$	0.1800	0.2500	0.3200	0.0267	0.0230	0.0190
$large$	0.1200	0.1700	0.2400	0.0443	0.0399	0.0348