The impact of monetary policy on bank balance sheets*

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Abstract

This paper uses disaggregated data on bank balance sheets to provide a test of the lending view of monetary policy transmission. We argue that if the lending view is correct, one should expect the loan and security portfolios of large and small banks to respond differentially to a contraction in monetary policy. We first develop this point with a theoretical model; we then test to see if the model's predictions are borne out in the data. Overall, the empirical results are supportive of the lending view.

1 Introduction

When the Federal Reserve tightens monetary policy, it exchanges bonds for bank reserves. A longstanding question is whether this interaction with the

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banking system has any effects beyond those on bond-market interest rates. That is, in addition to the textbook "money" channel, does monetary policy also work in part through a distinct "bank lending" channel?

Over the last few years, there has been a resurgence of interest in this question, and it has generated a good deal of both new research and controversy. In this paper, we propose to attack the question from a quite different angle than has other recent work, by examining what the so-called "lending view" has to say about cross-sectional differences in the way that bank balance sheets respond to a monetary policy shock. More specifically, we argue that if the lending view is correct, one should expect the loan and security portfolios of large and small banks to respond differentially to a contraction in monetary policy. We first develop this point with a theoretical model; then we test to see if our predictions are borne out in the data.

By focusing on disaggregated bank data, we can most directly address what skeptics seem to think is the weakest part of the case for the lending view: the proposition that the Fed can, simply by changing reserves, affect banks' loan supply schedules. A number of authors have argued that this proposition is theoretically dubious. For example, Romer and Romer (1990) emphasize that banks can always, if needed, finance themselves with nondeposit sources of funds. Thus, even if contractionary Fed policy can reduce the deposit financing available to the banking sector, banks can simply and frictionlessly make up the shortfall by issuing, say, large denomination CDs, medium-term notes, or some other security. The bottom line, according to Romer and Romer (1990) and others, is that bank loan supply is effectively completely insulated from Fed policy.

This argument is just an application of Modigliani-Miller logic to the banking firm. In a Modigliani-Miller world, shocks to the liability side of a bank's balance sheet should not affect its "real side" behavior, namely, its willingness to supply loans for a given interest rate. Therefore, in order to make a convincing case for a lending channel of monetary policy transmission, one has to establish that the Modigliani-Miller argument does not apply to banking firms in this context. That is, one has to show that because of capital market imperfections, shocks to banks' deposit base cannot be frictionlessly offset with other sources of financing, and therefore translate into "real" effects on their lending behavior.

We attempt to do so in two basic steps. First, we develop a theoretical model that is designed to: (1) illustrate how the existence of capital market imperfections facing the typical banking firm can generate a lending channel; (2) highlight the cross-sectional differences between banks with different degrees of access to nondeposit financing that arise when there are such capital market imperfections. Perhaps the most important thing to emphasize about this model of the banking firm is that it is exactly the same sort of model that has been widely applied to study the implications of capital market imperfections for *nonfinancial* companies.

Our second step is to begin to test the cross-sectional implications of this model empirically. Again, the types of tests that we use are very closely analogous to those used to study the investment behavior of nonfinancial firms. Loosely speaking, we test the following sort of prediction of our model: Fed tightening should have a disproportionately large impact on the lending behavior of smaller banks, who are more likely to have difficulty substituting into nondeposit sources of external finance. This directly parallels the empirical strategy in the literature on nonfinancial firms, where the test is typically of the following sort: shocks to internal liquidity should have a larger impact on the investment behavior of smaller companies, who are more likely to have a hard time accessing external sources of finance.

We stress the close relationship between our work here on banking firms and previous work on nonfinancial firms that face capital market imperfections because of what we see as a curious dissonance in the recent literature on monetary policy. On the one hand, as we discuss below, even most skeptics of the lending view have been very willing to embrace the importance of capital market imperfections at the level of the non-financial firm. However, at the same time, these same skeptics have implicitly tended to dismiss — often without any real direct evidence — the possibility of similar imperfections at the level of the banking firm.

In our view, there is no a priori reason to think that capital market imperfections should be less important for banking firms than for nonfinancial firms. Indeed, one might well expect them to be *more* pronounced, to the extent that these imperfections have their roots in information asymmetries between firms and their external capital suppliers. After all, banks specialize in holding portfolios of hard-to-value assets–assets for which information asymmetries tend to be substantial.

The remainder of the paper is organized as follows. In the next section, we present a brief overview of where the debate on the lending view now stands, and use this to motivate in more detail why our focus on the behavior of different types of banks can be helpful. Next, we develop our model. The following section describes the data to be used in the empirical work, and the one after that presents our empirical results. The final section concludes.

2 Where the debate on the lending view stands

In this section, we provide a brief sketch of the current state of play in the debate over the lending view of monetary policy transmission. Our aim is not to be exhaustive, but rather to give a quick idea of what sorts of empirical strategies have been adopted thus far.[1] This will help to show the motivation for the particular approach we take in this paper.

2.1 *A definition of the lending view*

For the purposes of clarity, it is useful to begin by defining exactly what we mean by the lending view. It is perhaps easiest to do so by contrasting the lending view of monetary policy transmission with the simpler and better known "money" view. In what we take to be the polar, pure money version of the transmission mechanism, there are only two assets–money and bonds, and a single interest rate. This interest rate is taken to be a summary statistic for all credit market conditions. That is, it is to be thought of as simultaneously capturing the return on government bonds, banks loans, real capital, etc. The textbook IS-LM model's version of monetary transmission is one example of what we would call the pure money view.[2]

There is a long literature that takes issue with the notion that a simple two-asset/one-interest-rate model is sufficient to capture the workings of monetary policy. In response to this perceived shortcoming, Brainard (1964), Tobin and Brainard (1963), Tobin (1970), and Brunner and Meltzer (1963, 1972, 1988) propose general equilibrium, multi-asset models which feature imperfect substitutability among a number of assets, and hence allow in principle for a number of different interest rates. We follow Bernanke and Blinder (1988) and interpret the lending view as a specific special case of these multi-asset models. In particular, in the lending view, there are now exactly three assets — money, bonds, and bank loans — that differ from each other in meaningful ways and must be accounted for separately when analyzing the impact of monetary policy shocks.

In this three-asset world, monetary policy can work not only through its impact on the bond-market rate of interest but also through its independent impact on the supply of bank loans. For example, even if a contraction in policy has little effect on the bond-market rate, it can in some circumstances have a very significant effect on the *spread* between loans and bonds, and therefore on the investment of those firms that rely on banks for financing. This latter effect is what we would call the lending channel in action.

Bernanke and Blinder's model makes it clear that there are two necessary conditions that must hold for there to be a distinct lending channel of monetary policy transmission: (1) some firms must be dependent on bank

[1] See Kashyap and Stein (1994) for a detailed survey.

[2] Note, however, that as we have defined the pure money view of the transmission mechanism — solely by reference to its simple two-asset feature — there are a wide range of alternative formulations that capture its essence. In addition to the IS-LM model, these include the dynamic equilibrium cash-in-advance models of Rotemberg (1984), Grossman and Weiss (1983), and Lucas (1990).

loans–i.e., some firms must be unable to frictionlessly substitute between bank loans and other forms of finance; (2) the Fed must be able, simply by conducting open-market operations, to shift banks' loan supply schedules.[3] As we noted in the Introduction, and as we will discuss in more detail momentarily, it is the plausibility of the latter condition that seems to be most in doubt.

2.2 *Tests using aggregate data*

An important empirical paper that helped to rekindle interest in the lending view is Bernanke and Blinder (1992). Their approach is simple and commonsensical: they look to see how aggregate bank balance sheet variables respond to changes in the stance of monetary policy, as proxied for by changes in the Fed funds rate. They find that when the Fed tightens, bank deposits drop immediately. Bank holdings of securities also fall immediately. Bank loans respond with something of a lag, but they too eventually decline. Finally, measures of aggregate output also respond to monetary impulses with a similar lag, thus declining roughly contemporaneously with bank loans.

While the Bernanke and Blinder (1992) findings are certainly consistent with the lending view, they also admit other interpretations. For example, one way to read their results is that tight monetary policy operates solely through the standard money channel to depress economic output and to reduce the *demand* for credit. Thus, there can be induced correlations between monetary policy, bank lending, and overall activity even if there is no lending channel.

In an effort to resolve this identification problem, Kashyap, Stein, and Wilcox (1993) consider the relative fluctuations in bank loans and a leading substitute for bank loans: commercial paper. They find that when the Fed tightens, commercial paper issuance rises sharply, even while bank loans are falling.[4] This makes it more likely that what has taken place is an inward shift in loan *supply*, as suggested by the lending view, rather than just an inward shift in loan demand.

However, not everyone has accepted the Kashyap, Stein, and Wilcox results as completely decisive, either. The gist of the objections, as put forth by Oliner and Rudebusch (1993) and others is this: Kashyap, Stein, and Wilcox achieve identification of loan supply effects under the implicit assumption that monetary policy shocks affect the demand for funds in a homogeneous fashion. But suppose instead, that for some unspecified reason, declines in

[3]In addition, like all models of monetary non-neutrality, there must be some form of imperfect price adjustment.

[4]As Friedman and Kuttner (1993) emphasize, there is an asymmetry in the movements of the two variables: the commercial paper response is both faster and stronger than the loan response.

aggregate demand fall disproportionately on the shoulders of smaller firms. If this is the case, small firms' demand for credit may fall *more* than large firms' demand for credit. Hence, commercial paper volume, which largely reflects large-firm borrowing, may rise relative to bank loans, even in the absence of a movement in bank loan supply.

These sorts of objections suggest that it may be hard to completely settle the debate using aggregate data. Unless one is willing to impose some a priori restrictions on the nature of credit-demand side shocks, it seems unlikely that one can unambiguously identify loan supply effects with the sort of aggregate "mix" variables used by Kashyap, Stein, and Wilcox–almost any movement in the composition of external finance can be explained away by appealing to a sufficiently creative story about heterogeneity in credit demand.

2.3 *Tests using disaggregated data on non-financial firms*

Given the inherent ambiguities associated with relying exclusively on aggregate data, a natural next step is to use disaggregated data to explore some of the cross-sectional implications of the lending view. In particular, the lending view predicts that tight monetary policy should pose more of a problem for small firms, who rely primarily on banks, than for large firms, who typically have greater access to nonbank sources of external finance.

A number of recent papers provide evidence that is consistent with this prediction, among them Gertler and Hubbard (1988), Gertler and Gilchrist (1994), Kashyap, Lamont and Stein (1994), and Oliner and Rudebusch (1994). Loosely speaking, all these papers can be interpreted as showing that after a tightening of monetary policy, liquidity constraints become significantly more pronounced for small firms.

Again, however, while these findings fit very nicely with the predictions of the lending view, they also are open to other interpretations. Specifically, it may be that the decline in economic activity that follows a contraction in monetary policy leads to an erosion of the value of small firms' collateral. In a world of information and/or agency problems, such a "collateral shock" will make it harder for small firms to raise external financing of *any sort*. Thus, the increased liquidity constraints may not reflect an inward shift in just bank loan supply, but rather a more general deterioration of small firms' creditworthiness. In other words, the evidence strongly rejects the implications of a frictionless capital market but does not necessarily pinpoint the nature of the deviation from perfect markets.

Indeed, most of those who have been skeptical of the pure bank lending view have embraced the collateral shock interpretation of the data. A noteworthy example is Oliner and Rudebusch (1994), who refer to this as a "broad credit channel"; see also Ramey (1992) for an endorsement of this view. What seems slightly odd is that in advancing this so-called broad credit channel, these authors are explicitly emphasizing the importance of capital market imperfections at the level of the nonfinancial firm. At the same time, in dismissing the narrower bank lending view, they are implicitly rejecting the importance of exactly the same sort of imperfections at the level of the banking firm.

2.4 *Our approach: tests using disaggregated data on banks*

As the above suggests, it now seems to be quite widely accepted that capital market imperfections at the level of nonfinancial firms can play a role in shaping the transmission of monetary policy. Thus, debate on the lending view has boiled down to the following question: can the Fed, merely by altering reserves, alter the loan supply behavior of banks? Or are banks, as Romer and Romer (1990) suggest, Modigliani/Miller creatures whose lending is unaffected by changes in their deposit liabilities?

To address this question most directly, one needs to look at how banking firms respond to changes in the stance of monetary policy. To oversimplify slightly, our empirical strategy can be thought of as a disaggregated version of that in Bernanke and Blinder (1992). Like they do, we will look at how bank deposits, securities holdings, and loans respond to shocks in monetary policy. Unlike in their paper, however, our focus will be on *cross-sectional differences* in these responses across banks of different sizes.

Before proceeding, we should emphasize that such a disaggregated approach has both a benefit and a cost. The benefit is that we can hopefully make more progress on the specific question articulated just above, namely: are banks Modigliani-Miller creatures with respect to Fed-induced deposit shocks? The cost is that our data are not appropriate for gauging the *aggregate* importance of any deviations from Modigliani-Miller at the bank level. For example, even if we find that Fed tightening leads to a pronounced contraction in bank loan supply, we cannot with our data say how much this ultimately impacts investment at the level of nonfinancial firms. Perhaps the nonfinancial firms can switch to alternative sources of funds at relatively low cost, so the overall impact on investment is only modest.[5]

3 The model

This section develops a model of bank portfolio behavior. As stated above, the main goals are: (1) to show how capital market imperfections at the bank level can generate a lending channel of monetary policy transmission;

[5]However, there is a substantial literature that suggests that bank loans are in fact "special" for some firms, so that such switching would not be frictionless. See Kashyap and Stein (1994) for a discussion and references.

and (2) to derive cross-sectional predictions about how such capital market imperfections *differentially* shape the portfolio response of large and small banks to a monetary shock. These cross-sectional predictions can then be used to test the model.

It should be noted that the model is only partial equilibrium in nature. Since we are only making cross-sectional comparisons, we do not tie down the Treasury market rate, but rather fix it exogenously. Also, we adopt a very simplistic view of how monetary policy affects individual banks' deposit bases. In our model, when the Fed tightens, all banks see their deposits fall by the same amount, and they can do nothing to offset this fall. That is, we do not allow for inter-bank competition for deposits. The model can be generalized to allow for such inter-bank competition, but this does not alter the basic cross-sectional predictions that we focus on.

We begin by specifying banks' asset and liability choices, taking the return on bank loans as exogenous. We then close the model with two alternative specifications of loan demand.

3.1 *Bank asset and liability management*

Our model has two time periods. As will become clear, this is done as a minimalist way of generating a "precautionary," or "buffer stock," motive for banks to hold securities in the first period.

In each of the two periods, a bank's balance sheet has two items on the asset side, and two on the liability side. On the asset side, the bank can make loans of L at time 1. These loans yield a return of r. For the time being, r is taken as exogenous; it will be endogenized below when we develop the loan demand side of the model. Once made, these loans *cannot be liquidated* at time 2. Thus, the bank must hold loans of at least L at time 2. Indeed, to make things especially simple, we assume that no new lending opportunities arise at time 2, so the loan balance remains exactly at L at this time.

This formulation is more extreme than it needs to be. All that matters for our results is that banks face some cost in liquidating loans early.[6] We are simply taking the polar case where this cost of early liquidation is infinite.

The bank can also invest an amount S in securities at time 1. These securities, which can be thought of as Treasury bills, yield a return that is normalized to zero. Thus the yield on loans, r, is really a measure of the *loan-security spread.* In this sense, r is a pure measure of the lending channel of monetary policy. That is, if a monetary contraction increases r in our model, this will be a manifestation of the lending channel in action. Conversely, if r is endogenously determined to be equal to zero at all times, this means that the lending channel does not exist.

[6]This assumption is a standard one–see, e.g., Diamond and Dybvig (1983).

The key difference between loans and securities is that securities can be costlessly liquidated at time 2. As will become clear, it is because of this better "liquidity" that banks will in equilibrium choose to hold securities at time 1 even when they offer an inferior return to loans – i.e., even when $r > 0$.

On the liability side, one important source of financing for banks is demand deposits. At time 1, deposits are M_1, and at time 2, they are M_2. We assume that M_1 and M_2 are out of the control of individual banks, and are determined by Federal Reserve policy. That is, by tightening policy at time 1, the Fed effectively creates a net funding shock for the typical bank.[7]

Our principal focus below will be on the effect of a change in M_1 on a bank's holding of loans and securities, L and S, respectively. However, this effect will depend on the stochastic structure of shocks to M_1 and M_2. In particular, we need to specify both (1) the extent to which a shock to M_1 is persistent or temporary; and (2) the degree of uncertainty at time 1 surrounding the realization of M_2.

To do so, we pick the following simple formulation. Once M_1 is realized, it is common knowledge that M_2 is distributed as follows:

$$M_2 \text{ is uniform on } [\rho M_1 + (1-\rho)M - \gamma/2, \rho M_1 + (1-\rho)M + \gamma/2] \quad (1)$$

Thus, M_2 is uniformly distributed with a mean of $\rho M_1 + (1-\rho)M$. The parameter ρ is a measure of the persistence of monetary shocks–the larger is ρ, the more permanent are the shocks. The parameter γ is a measure of the variance of these shocks.

Finally, in addition to deposits, banks can also finance themselves by raising non-deposit external finance at both times 1 and 2. We denote the incremental amounts raised at these times by E_1 and E_2, respectively. So, at time 2, the total amount of non-deposit finance on the bank's balance sheet is $E_1 + E_2$.

The model captures the notion that, when the Fed tightens, banks have alternative ways to raise funds–they are not limited to simply cutting loans or securities. Our variables E_1 and E_2 can be thought of as a catch-all category

[7]This is obviously a gross oversimplification. What we have in mind is that by controlling reserves, the Fed can control the *aggregate* amount of reservable deposits. In general, of course, this does not mean that it can directly control the deposits of any given individual bank. However, if banks are prohibited from competing among each other for deposits (say, because of interest-rate ceilings) no individual bank will be able to take any action to offset an erosion of its own deposits. In this case, when the Fed tightens, the typical bank will experience an exogenous shock to its deposits of the sort that we assume.

In a world without interest-rate ceilings on deposits, things are somewhat more complicated. Now any individual bank can react to a tightening in Fed policy by competing more aggressively for deposits, so it does not view its level of deposits as exogenous. However, the empirical predictions that we focus on continue to hold in such a setting.

for any sources of bank funding that are outside the control of the Fed's reserve policy. This would include large denomination CDs — if such CDs are not subject to reserve requirements — as well as many other funding vehicles such as medium-term notes, subordinated debt, equity issues, etc.[8]

Our entire model hinges on the assumptions we make about the costs of raising nondeposit external finance. We assume that the costs at time 1 are given by $\alpha_1 E_1^2/2$, and analogously, the costs at time 2 are given by $\alpha_2 E_2^2/2$. The specific functional form is not critical, but the fact that there are increasing marginal costs of external finance clearly is.

In the polar case where $\alpha_1 = \alpha_2 = 0$, external finance can be raised in perfectly elastic supply at the security-market interest rate of zero. This is essentially the Modigliani-Miller style assumption made by Romer and Romer (1990). As will be seen shortly, this assumption is sufficient to shut down the lending channel completely–it implies that $r = 0$ always.

However, our working hypothesis — and this is what we will be seeking to test below — is that the assumption that $\alpha_1 = \alpha_2 = 0$ is likely to be unrealistic. In other words, the Modigliani-Miller proposition does not hold, and there are imperfections in the market for nondeposit external finance. Take for example the case of large denomination CDs that is emphasized by Romer and Romer (1990). Given that such CDs are not federally insured, investors purchasing them must concern themselves with the quality of the issuing bank. If there is some degree of asymmetric information between the bank and investors, the standard sorts of adverse selection problems (see, e.g., Myers and Majluf 1984) will arise.[9] These considerations will tend to make the marginal cost of external financing an increasing function of the amount raised.

Indeed, rather than simply assuming the form we do for costs of external finance at times 1 and 2, we could derive our results in a multi-period adverse selection model. A companion paper, Stein (1994), sketches exactly such a model. While this sort of adverse selection model is expositionally much

[8]In practice, CDs have been completely exempt from reserve requirements since 1990. However, even before then, CDs were typically subject to much lower reserve requirements than demand deposits. As Romer and Romer (1990) observe, reserve requirements on demand deposits have typically been in the 10- to 20-percent range during the postwar period; while the requirement on large-denomination CDs of short maturity has ranged from 3 to 6 percent.

[9]The notion that investors are concerned with the default risk of large CDs — and have less-than-perfect ability to assess such risk — is consistent with the facts that (1) bank CDs are evaluated by no less than five rating agencies; and (2) the rates paid by different quality issuers can vary considerably. More generally, evidence that commercial banks face adverse selection problems in raising external finance is provided by the event study results of Keeley (1989), Poloncheck, Slovin, and Sushka (1989), Wansley and Dhillon (1989), and Cornett and Tehranian (1994). All of these papers document that stock issues by banks are taken as "bad news" — they are greeted with significantly negative stock-price reactions.

more cumbersome than the simple quadratic-cost formulation we adopt, it yields all the same basic predictions. Accordingly, the quadratic-cost version we present here is best thought of as a heuristic device that communicates the main points of the more elaborate adverse selection model, illustrates the logic behind our empirical work, but spares the disinterested reader some of the technical details.

Of course, adverse selection is not the only way to generate increasing marginal costs of external finance. As much recent work in corporate finance and macroeconomics makes clear, this property is shared by a number of other models involving agency and/or information problems. To take just one other example, Froot, Scharfstein and Stein (1993) demonstrate explicitly how a variant of the costly-state-verification model due to Townsend (1979) and Gale-Hellwig (1985) leads to a convex cost function for external funds. Thus, all we are really doing with our quadratic-cost formulation is imputing to banks — in shorthand form — a generic version of the sort of capital market imperfection that is by now standard in the literature on nonfinancial firms.[10]

Even if information or agency problems are not present, there may be other reasons why a bank effectively has increasing costs of replacing lost deposits. In a costly search setting, potential investors in a bank's nondeposit liabilities may not all be aware of the return opportunities offered by that bank. In order to draw in more investors, the bank might therefore have to spend more, either by advertising or by raising its rates relative to those on well-known alternatives such as T-bills.

The bottom line of this discussion is twofold. First, there are a number of reasons why it seems plausible that banks, like nonfinancial corporations, might have increasing costs of external finance. Second, as with nonfinancial corporations, it seems likely that these costs would be more pronounced for small banks than for large banks. That is, it seems reasonable to hypothesize that α_1 and α_2 would be larger for small banks. This latter observation will be the basis for our cross-sectional tests.

Having spelled out our basic assumptions, we are now in a position to characterize a bank's portfolio choice at times 1 and 2. It is easiest to work backwards from time 2. The bank enters this period with loans of L, securities of S, and nondeposit financing of E_1 already on the balance sheet. The time-2 value of demand deposits, M_2 is then realized. We can distinguish among two cases:

[10]In terms of applications of this paradigm to banking firms, our model is perhaps most closely related to recent work by Lucas and McDonald (1992), who explicitly adopt an asymmetric information model of bank portfolio choice. Although they do not focus on monetary policy, their model shares with ours the feature that imperfections in the market for nondeposit external finance give rise to a precautionary demand for securities.

Case 1: $E_1 + M_2 > L$. In this case, the bank can continue to fund its illiquid loan portfolio without resorting to any new external finance at time 2, simply by drawing down on its buffer stock of securities. Note that it will always prefer to draw down the securities first, since this is effectively a zero-cost way of making up any funding shortfall.

Case 2: $E_1 + M_2 < L$. In this case, even after liquidating all of its securities holdings, the bank is still short of funds. Thus, it has to make up the rest with new external financing, E_2.

The net result is that E_2 is given by:

$$E_2 = max(0, L - E_1 - M_2) \tag{2}$$

The costs associated with this new external funding are given by $\alpha_2 E_2^2/2$. From the perspective of time 1, the exante expectation of time-2 funding costs is given by:

$$\text{Expectation } (\alpha_2 E_2^2/2) = \alpha_2(L - E_1 - \rho M_1 - (1-\rho)M + \gamma/2)^2/6 \tag{3}$$

We are now in a position to formulate the time-1 optimization problem. At time 1, the bank chooses L and E_1 (and hence implicitly also chooses $S = M_1 + E_1 - L$) to maximize:

$$max : rL - \alpha_1 E_1^2/2 - \alpha_2(L - E_1 - \rho M_1 - (1-\rho)M + \gamma/2)^2/6 \tag{4}$$

The solution to this problem is given by:

$$E_1 = r/\alpha_1 \tag{5}$$

$$L = r/\alpha_1 + 3r/\alpha_2 + \rho M_1 + (1-\rho)M - \gamma/2 \tag{6}$$

$$S = M_1 + E_1 - L = -3r/\alpha_2 + (1-\rho)(M_1 - M) + \gamma/2 \tag{7}$$

The results have an intuitive interpretation. First, the amount of external funding at time 1, E_1, is simply set so as to equate the marginal cost of obtaining an additional dollar of funds, $\alpha_1 E_1$, to the marginal return on an additional loan, r.

Second, loan supply is positively influenced by the value of M_1, as well as by the loan-security spread r. The closer are α_1 and α_2 to zero, the more responsive are loans to r. In the limiting case where either α_1 or α_2 is zero, any positive value of r generates an infinite loan supply. Finally, loan supply is negatively influenced by γ which is a measure of the conditional variance of M_2. This is because the more uncertainty there is about M_2, the less inclined banks will be to hold illiquid loans as opposed to liquid securities.

Finally, securities holdings are positively related to both M_1 and the conditional variance of M_2, and negatively related to the loan-security spread

r. Also, since banks hold securities to avoid having to raise external funds at time 2, those that find external financing particularly costly — i.e., those with higher values of α_2 — will hold more securities. One important piece of intuition that will play a role later on is this: a bank's portfolio mix between loans and securities is informative about the spread r that it is facing at the margin. Therefore, if we see a bank shift towards holding a greater ratio of loans to securities, this indicates that it has experienced a rise in r.

3.2 *Equilibrium with a homogeneous competitive loan market*

The simplest way to close the model is by assuming that there is a single, homogeneous economy-wide loan market. In this loan market, demand should be a function of the loan rate r, as well as general economic conditions, which we denote by Y. A linear representation of aggregate loan demand is thus:

$$L_D = Y - kr \tag{8}$$

Market equilibrium is then determined by equating aggregate loan demand to aggregate loan supply, where aggregate supply is the sum of the supplies of the individual banks, which are given by (6). Of course, these individual banks can each have their own values of α_1 and α_2.

The key empirical implications of the model flow from these differences in α_1 and α_2. To illustrate these implications most cleanly, let us assume that changes in the stance of monetary policy have an equal effect on the deposits of all banks. That is, for any two banks i and $j, dM_1^i = dM_1^j$.[11] This allows us to summarize the stance of policy simply by an unsuperscripted M_1.

We can now differentiate (6) and (7) to obtain the following expressions for any bank i:

$$dL^i/dM_1 = \rho + (1/\alpha_1^i + 3/\alpha_2^i)dr/dM_1 \tag{9}$$

$$dS^i/dM_1 = (1-\rho) - (3/\alpha_2^i)dr/dM_1 \tag{10}$$

Given the nature of loan demand, one can show that the effect of monetary policy on the loan-security spread, dr/dM_1, has the form:

$$dr/dM_1 = a dY/dM_1 - b \tag{11}$$

where a and b are both positive constants. So long as the direct effect of monetary policy on loan demand, dY/dM_1, is not too large, it will be the case that $dr/dM_1 < 0$–i.e., that monetary policy works in part via a lending channel. In this case, equations (9) and (10) yield the following testable predictions:

[11] We are making this assumption only to illustrate the logic of our tests more transparently. We will be careful to check that it does not color our empirical work below.

Prediction 1: The lending volume of small banks (those with larger values of α_1 and α_2) declines more rapidly in response to a given contraction in deposits than does the lending volume of large banks.

Prediction 2: The securities holdings of small banks decline more slowly in response to a given contraction in deposits than do the securities holdings of large banks.

These predictions follow immediately from (9) and (10), in conjunction with the observation that, in a single economy-wide loan market, there is a single loan rate, so dr/DM_1 is the same for all banks. The intuition for the lending volume result is straightforward. Since we have assumed that all banks are hit by the same deposit and loan demand shocks, cross-sectional differences in lending volume must reflect differential loan supply responses. And if small banks find it costlier to make up for a monetary-policy-induced shortfall in funds, they will in fact cut their loan supply by more.

The securities result is slightly subtler. All else equal, the more a bank cuts its securities at time 1, the more it may be forced to seek external finance at time 2. Because small banks find this possibility more daunting, they value securities more at the margin, and hence are less willing to cut them.

Thus, if one is willing to maintain the assumption of a single, homogeneous loan market, testing the model is fairly straightforward. However, the maintained assumption required to do the test may not be very appealing. To see why, suppose that the evidence does in fact support both predictions. A natural skeptical reaction might be: "This does not necessarily prove that the monetary contraction had more of an effect on small banks' loan *supply.* Rather, it might be that the change in policy had more of an effect on small banks' loan *demand.* Perhaps small banks tend to lend to smaller, more recession-sensitive customers. Thus, when there is a tightening of policy and aggregate demand falls — say due to the textbook 'money channel' in action — the loan-demand curve facing small banks shifts in more than the loan-demand curve facing big banks. Given this inward shift in loan demand, small banks will naturally tend to lend less and invest more in securities relative to large banks."

3.3 *Heterogeneous loan demand*

In order to entertain this possibility, one obviously has to consider a situation where banks can face heterogeneous demand conditions. The simplest way to do so is to treat each individual bank as a monopolist, facing its own individual demand curve for loans. Although this is obviously extreme, it is sufficient for the present purposes. Moreover, the notion that banks have some degree of market power with their customers - due, possibly to informational "lock-in" effects — is supported in recent theoretical and empirical research. (See, e.g., Sharpe (1990), Rajan (1992) and Petersen and Rajan (1992)).

We now assume that *each bank* i faces its own loan-demand schedule of the following form:

$$L_D^i = Y^i - kr^i \tag{12}$$

Accordingly, each bank's loan-demand schedule may be shifted differently by contractionary monetary policy. That is, Y^i, and hence dY^i/dM_1, may vary systematically across banks. This allows us to consider the possibility that, say, the loan demand facing small banks is harder hit by a monetary-policy-induced recession than is the loan demand facing large banks. Also, each bank now has its own loan-security spread r^i.

In this case, the bank's portfolio decisions are of the form:

$$E_1 = (r + Lr'(L))/\alpha_1 \tag{13}$$

$$L = (1/\alpha_1 + 3/\alpha_2)(r + Lr'(L)) + \rho M_1 + (1-\rho)M - \gamma/2 \tag{14}$$

$$S = M_1 + E_1 - L = -3(r + Lr'(L))/\alpha_2 + (1-\rho)(M_1 - M) + \gamma/2 \tag{15}$$

These equations are of exactly the same form as (5)-(7) above, except that $(r + Lr'(L))$ has replaced r everywhere. This is a consequence of the fact that banks now behave as monopolists rather than price-takers. Note that by virtue of our linear-demand assumption, $r'(L)$ is simply given by $-1/k$.

Correspondingly, the reaction of bank i's loan volume and securities holdings to a change in monetary policy is given by:

$$dL^i/dM_1 = f(\rho + (1/\alpha_1^i + 3/\alpha_2^i)dr^i/dM_1) \tag{16}$$

$$dS^i/dM_1 = 1 - g\rho - (3f/\alpha_2^i)dr^i/dM_1 \tag{17}$$

where $f = 1/(1 + 1/k\alpha_1^i + 3/k\alpha_2^i)$ and $g = (1 + 1/k\alpha_1^i)/(1 + 1/k\alpha_1^i + 3/k\alpha_2^i)$ are both between 0 and 1. The expression for loans is of the same form as (9), with two differences. First, it has been modified to take account of the effects of monopoly power — this accounts for the presence of the new parameter f. In the limiting case as k becomes infinite — i.e., as loan demand becomes perfectly elastic — f converges to one, as in the competitive case. Second, and much more important for our purposes, dr^i/dM_1 can now vary across banks.

It is easy to show that dr^i/dM_1 has the following form:

$$dr^i/dM_1 = a(\alpha_1^i, \alpha_2^i)dY^i/dM_1 - b(\alpha_1^i, \alpha_2^i) \tag{18}$$

where what is important to now note is that both $a(\alpha_1^i, \alpha_2^i)$ and $b(\alpha_1^i, \alpha_2^i)$ are *increasing* functions of α_1^i and α_2^i. One implication of (18) is that if dY^i/dM_1

is close to zero, so that loan-demand shifts do not play an important role, then the loan rate for small banks will be more sensitive to monetary policy than will the loan rate for large banks. This makes intuitive sense: it is harder for small banks to offset a loss in reserves by raising external funds; thus they wish to cut lending by more and will do so until the loan rate rises by more. On the one hand, it is also possible that in equilibrium the loan rate for small banks will be less sensitive to monetary policy. This can happen if loan demand for small banks is more procyclical–i.e., if dY^i/dM_1 is significantly greater for small banks.

Equations (16) and (18) therefore make precise the criticism raised earlier. One can no longer unambiguously identify loan-supply effects of monetary policy simply by comparing dL/dM_1 across banks. On the one hand, dL/dM_1 could be larger for small banks because of the loan-supply effect — small banks' supply schedule shifts in by more when the Fed tightens. On the other hand, dL/dM_1 could also be larger for small banks because of a loan-demand effect — that is, because the demand for small bank loans is more procyclical than the demand for large bank loans.

While one may no longer be able to achieve identification by considering just the differential movements in lending volume across banks, it may be possible to do better by also considering movements in securities holdings. Intuitively, the presence of simultaneous loan demand and supply shocks implies that information on loan volume alone is insufficient, but that information on lending *rates* would be very helpful. For example, if loan demand falls for some subset of banks, then their lending volume will fall and their loan rate r will fall, too. If on the other hand, loan supply falls, then lending volume will fall, but the loan rate r will rise. Even though movements in r are not observable, they might in principle be inferred by looking at movements in securities.

Unfortunately, using securities movements to infer movements in r is somewhat tricky. This can be understood by examining equation (17). There are now two competing effects. First, as in the homogeneous demand case, the direct effect of a large α_2 is to make securities holdings *less* sensitive to monetary policy for small banks. However, this may be offset if dr^i/dM_1 is larger in absolute magnitude for small banks. If the latter effect is strong enough, it may even be possible to have a situation where small banks cut their securities holdings by *more* than large banks in the wake of a contraction in monetary policy.

The intuition for this sort of result is as follows. A contraction in monetary policy initially leads a given small bank to cut loan supply. If the loan-demand schedule facing the bank is more or less unchanged, *and* this demand schedule is relatively inelastic, there will be a sharp increase in the bank's loan-security spread. This will lead the bank to favor loans in its portfolio relative to securities, and hence to be more willing to cut securities in order to maintain lending volume.

Prediction 3: A given contraction in deposits can cause securities to fall more for small banks than for large banks, but only under certain conditions. In particular, dr^i/dM_1 must be significantly larger in absolute value for small banks, which in turn requires that: (1) loan-demand shocks not differ too much across banks; and (2) loan demand be sufficiently inelastic (i.e., that k be relatively small). If these two requirements are not both satisfied — as, e.g., in the perfect competition homogeneous demand case, where (2) fails to hold — then the prediction will be reversed.

The upshot of this is that the relative movements in securities holdings across large and small banks may be able to provide a decisive test for loan-supply effects. If we were to find that small banks cut their securities by more than big banks after a contraction in monetary policy, this could only be explained by the loan-supply story. Indeed, such a finding would directly contradict the competing hypothesis that small-bank loan *demand* is more procyclical.

However, such a test is a potentially stringent one. This is because the data have to be able to jointly reject *both*: (1) the null hypothesis that there are no loan-supply effects; as well as (2) the hypothesis that loan demand is fairly elastic. Therefore, we may well fail to find the evidence that we are looking for, even if loan-supply effects are in fact very important.

The overall message to take away from the model is that we have two basic types of cross-sectional tests to consider. The first is to simply compare the evolution of large and small bank *lending volume* in response to a monetary shock. Our theory predicts that small-bank lending will react more strongly. The potential problem with this test is that it may not be stringent enough, in the sense that it may not adequately discriminate between loan-supply effects and heterogeneous demand shocks.

The second test is to compare the evolution of large- and small-bank *security holdings* in response to a monetary shock. If small banks react more sensitively along this dimension too, we would consider this to be strong evidence in favor of our model. However, if large banks react more sensitively, the interpretation is ambiguous–such a finding would certainly fit with the homogeneous demand version of our model, but could also be ascribed to heterogeneous demand shocks.

4 Data

4.1 *Data sources*

The data on loans, securities, and deposits that are used to test the model are taken from the quarterly regulatory reports that all federally insured banks must submit to the Federal Reserve. The primary advantage of drawing on the "Call Reports" is that they provide a nearly comprehensive survey of banks operating in the United States. The main disadvantage is that the reports are designed to provide information for regulatory purposes. Because of this regulatory focus, the same information is not necessarily collected for all banks–big banks are required to provide more information. Similarly, as the banking industry evolves the type of information that is collected changes, so that constructing long time series is often difficult.

These general characteristics of the Call Reports constrain our empirical work in two ways. First, a consistent format for the reports to which we had access is only available starting in 1976. So our sample begins in 1976, and runs through 1992 Q2. Even starting at this point, we are still only able to track series that are collected for all banks. To ease some of the regulatory burden on large banks, large banks are only required to supply data on a consolidated basis, i.e., aggregating foreign and domestic data. As a theoretical matter, it is not obvious whether it makes more sense to use consolidated or domestic-only data–this would in principle depend on the extent to which banks' domestic and foreign offices operate separately from one other.[12] However, because of the data collection convention, we have no choice but to study the consolidated data.

A second significant constraint in using the Call Reports is that a major overhaul in the format of the reports occurred in the first quarter of 1984. At that point, banks were asked to provide much more detailed data and the definitions of many series were adjusted. For instance, the breakdown on the types of securities that were required to be reported was adjusted. Prior to 1984, holdings of various types of U.S. government securities and state and local securities were separately reported. Following 1984, these securities were lumped together into a single series that also included holdings of all other bonds, stocks, and securities. Thus, it is impossible to reliably track disaggregated types of securities. While smaller types of data definition changes occur almost continuously, the 1984 Q1 shift was so significant that it affected almost all series, so in our empirical work we include a dummy variable to account for this shift.

A final consideration to note is that we are using data on banks, not bank holding companies. In many cases, a single bank holding company may own several of the banks in our sample. This distinction matters when we assign banks to size categories. For example, it is possible that we will assign a given bank to the "small" category, even if it is a subsidiary of a very large bank holding company. Again, it is not obvious what is the theoretically correct thing to do. However, the important point to recognize is that any misclassifications will only have the effect of making our empirical tests more

[12]We do, however, limit the sample to domestically chartered banks.

conservative–they will make it harder to identify any differences across size categories that do in fact exist.

The remaining data on inflation, interest rates, and output growth are taken from the Citibase data bank. A complete description of the Citibase series and the Call Report data is provided in the data appendix.

4.2 *Formation of size categories*

A first step in our analysis is to sort banks into categories that reflect differences in the costs of raising external funds. We partition banks based on their total assets, reflecting the hypothesis that large banks face lower costs of external financing. We then study the time series movements in the different categories. A potential problem with this type of exercise is that our series could be affected by banks that drift *across* categories. For instance, if several small banks merge to form one big bank, then at the time of the merger the total assets of the "big" category will surge and the total assets of the "small" category will drop.

To avoid these sorts of problems, we adopt the following procedure. In any two adjacent quarters, say 1986 Q1 and Q2, we identify all the banks that have not undergone a merger and that have complete data for both quarters–therefore banks that fail or are newly born are also excluded. We then rank all banks by their total assets in the first quarter (i.e., 1986 Q1) and use this ranking to assign them to a particular size category. We then form 1986 Q1 and 1986 Q2 aggregated balance sheets, summing up all the banks in a given size category. Using these aggregated balance sheets, we can then compute for each size category the growth rates for the variables of interest–e.g., loans, securities, etc. We then repeat the entire procedure for the next pair of quarters, 1986 Q2 and 1986 Q3. Thus, we reconstruct our size categories from scratch every quarter in order to compute a careful set of growth rates for that quarter.

The main advantage of this procedure is that it prevents banks' crossing between categories from influencing the growth rates. This approach also allows us to use the maximum amount of data, since in any quarter when a bank is not involved in a merger, it will be included in one of the size categories. Unfortunately, by focusing on growth rates we lose the ability to recover the levels for the data–although changes in data definitions already would impair our ability to consistently track the levels of most series.[13]

[13]The cumulative growth rates that are implied by our procedure may also be systematically understated if banks that engage in mergers tend to grow faster than average. This is another reason why any levels compiled from integrating our growth rates need to be interpreted with caution.

4.3 *A snapshot of bank balance sheets for different size categories*

Table 1 gives some basic information on what bank balance sheets look like for different size categories. We focus on a date roughly at the midpoint of our sample period — 1984 Q2 — and report balance-sheet data for six different size categories: banks below the 75th percentile by asset size; banks between the 75th and 90th percentiles; banks between the 90th and 95th percentiles; banks between the 95th and 98th percentiles; banks between the 98th and 99th percentiles; and banks above the 99th percentile.

Table 1:
Composition of Bank Balance Sheets
as of 1984 Q2

		Asset Cutoff used to Determine Size Category:				
	Below 75th Percentile	Between 75th and 90th Percentile	Between 90th and 95th Percentile	Between 95th and 98th Percentile	Between 98th and 99th Percentile	Above 99th Percentile
Number of Banks	10710	2142	714	429	143	142
Mean Assets ($ millions)	27.2	96.6	199.6	454.7	1213.5	8523.5
Median Assets ($ millions)	23.6	92.1	191.5	411.1	1165.9	3743.7
Fraction of Total System Assets	.131	.093	.064	.088	.078	.545
Fraction of Total Assets in Size Category						
Cash & Securities	.386	.374	.354	.339	.318	.248
Fed Funds & Repos Lent	.050	.047	.046	.050	.050	.031
Total Loans	.519	.535	.556	.566	.585	.621
Real Estate Loans	.187	.207	.212	.191	.181	.115
Loans to Depos. Inst.	.002	.004	.007	.011	.023	.051
Agricultural Loans	.076	.030	.014	.008	.007	.006
C&I Loans	.126	.153	.172	.187	.188	.281
Loans to Indiv.	.122	.129	.132	.137	.140	.075
Other Loans	.011	.010	.014	.018	.025	.073
Total Deposits	.882	.880	.864	.830	.800	.729
Transaction Dep.	.235	.240	.239	.250	.250	.172
Large Deposits	.101	.118	.131	.140	.144	.123
Brokered Dep.	.002	.002	.003	.002	.011	.019
Fed Funds & Repos Borrowed	.010	.020	.037	.066	.100	.100
Subord. Debt	.001	.001	.002	.003	.004	.005
Other Liabilities	.018	.021	.025	.031	.034	.118
Equity	.089	.078	.072	.070	.062	.048

Several regularities emerge. On the asset side, larger banks hold significantly less in the way of cash and securities and make more loans. This fits with the basic spirit of our model–we argued above that smaller banks need bigger buffer stocks of cash and securities because of their inability to raise external finance easily on short notice. Within the category of loans, larger banks tend to focus relatively more heavily on C&I lending, while small banks tend to concentrate relatively more on agricultural, real estate, and consumer lending.

On the liability side, the smallest banks have a very simple capital structure–they are financed almost exclusively with deposits and common equity. In contrast, larger banks make significantly less use of deposits and also tend to have substantially less equity.[14] The difference is made up by a number of other forms of borrowing. For example, the largest two percent of banks make heavy use of the Fed funds market to finance themselves; the smallest banks do virtually no borrowing in the Fed funds market. Given that Fed funds are a form of unsecured borrowing, this difference again fits with the spirit of our model–small banks seem to find it harder to raise financing with instruments where credit risk is an issue.

5 Empirical results

5.1 *The response of bank deposits to a monetary shock*

Before testing our mdoel's predictions regarding the response of bank loans and securities to a monetary shock, we first do some preliminary runs with bank deposits. The idea here is just to check a basic premise of our theory–namely, that a tightening in monetary policy does in fact lead to a contraction in the deposits available to *both* large and small banks. That this relationship holds for the aggregate banking sector has already been established by Bernanke and Blinder (1992); however, we want to make sure that it holds across all different size classes of banks. As suggested in the previous section, we have no a priori reason to believe that the effect should be stronger for any particular class.

We follow Bernanke and Blinder (1992) and others by using the change in the Fed funds rate as our primary indicator of changes in the stance of monetary policy.[15] In all cases, the dependent variable is the growth rate of nominal "core deposits" for a given size class, where "core deposits" are

[14]The differences between large and small bank equity underscores the fact that our use of bank size as a proxy for external market access is an imperfect one. All else equal, one might expect that better capitalized banks would have an easier time raising external funds. For example, the better capitalized is a bank, the less of a problem asymmetric information poses when it attempts to raise funds with uninsured debt liabilities such as large CDs or subordinated debt. Thus, the stronger capital positions of small banks may well be — like their larger holdings of cash and securities — an endogenous response to capital market imperfections. If so, this would tend to attenuate any observable differences between large and small banks, thereby making it harder for us to find the sorts of results we are looking for. Clearly, if we were to further disaggregate the data, it would make sense to control separately for both a bank's size and its capital position.

[15]We also experimented with using the Romer and Romer (1989) dates as an indicator of monetary policy. See below for more details.

defined as total deposits less any deposits in denominations greater than \$100,000. We exclude these large "wholesale" deposits because, as suggested by Romer and Romer (1990), they have been subject to low reserve requirements and may in principle be used by banks to offset Fed-induced shocks to core deposits. Thus, in the language of our model, Romer and Romer might argue that wholesale deposits are really a part of E, not M. However, as it turns out, the results that we present in Table 2 are little changed if we instead use total deposits (as did Bernanke and Blinder) instead of core deposits.

Table 2:
Core Deposits Regressions
(Δ Nominal Core Deposits is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag				Sum
			1	2	3	4	(t-stat)
1. BIG	ΔFed funds	ΔCPI	-1.04	-1.17	-0.47	-0.34	-3.02 (-1.53)
1. SMALL 98	ΔFed funds	ΔCPI	-2.23	-0.89	-1.53	0.25	-4.40 (-2.37)
1. SMALL 95	ΔFed funds	ΔCPI	-2.22	-1.08	-1.56	0.17	-4.60 (-2.63)
1. SMALL 90	ΔFed funds	ΔCPI	-2.17	-0.92	-1.49	0.19	-4.38 (-2.68)
1. SMALL 75	ΔFed funds	ΔCPI	-2.07	-0.86	-1.46	0.12	-4.26 (-2.90)
2. BIG	ΔFed funds	Δngdp, ΔCPI	-2.05	-2.06	-0.19	0.48	-3.82 (-1.24)
2. SMALL 98	ΔFed funds	Δngdp, ΔCPI	-2.68	-0.08	-0.79	0.61	-2.94 (-1.02)
2. SMALL 95	ΔFed funds	Δngdp, ΔCPI	-2.72	-0.34	-0.92	0.51	-3.46 (-1.29)
2. SMALL 90	ΔFed funds	Δngdp, ΔCPI	-2.65	-0.32	-0.90	0.46	-3.41 (-1.36)
2. SMALL 75	ΔFed funds	Δngdp, ΔCPI	-2.63	-0.51	-0.96	0.27	-3.84 (-1.69)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Both specifications 1 and 2 are estimated by OLS.

In our first specification in Table 2, we regress the growth rate of nominal core deposits against four lags of the change in the Fed funds rate, as well as four lags of the growth rate of the CPI.[16] (In every specification that we report below, we also always include four lags of the dependent variable, four quarterly dummies, and a dummy for 1984 Q1, when some of the data definitions were changed slightly.) We repeat this specification for each of five size classes: BIG represents the largest 1% of all banks; SMALL 98 represents the smallest 98%; SMALL 95 represents the smallest 95%; etc.

The results of the first specification suggest that a contraction in monetary policy has a quite similar effect on core deposits across size classes. In particular, in each of the five cases, the sum of the coefficients on the funds rate is negative — as expected — and of roughly the same magnitude (although the sum is somewhat smaller for the BIG class). The sum is also strongly significant for all but the BIG class, where it is marginally significant.

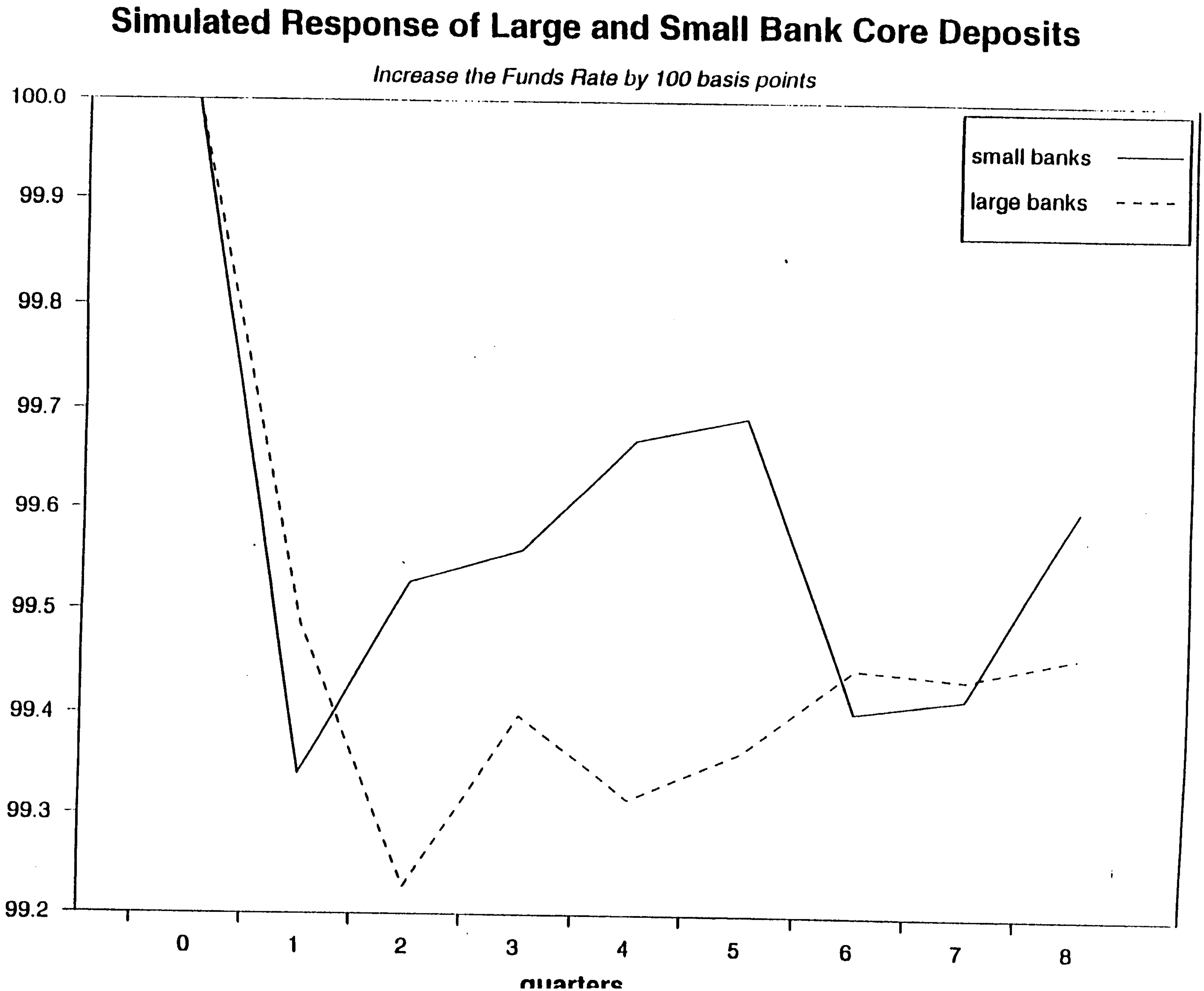
In our second specification, we add four lags of the growth in nominal GDP as an additional control variable. The results are not much different; now the sum of the coefficients on the funds rate looks to be virtually identical across size classes, with the largest and smallest classes having sums of -3.82 and -3.84, respectively. Since the data are annualized, these estimates imply that a one-percent increase in the funds rate eventually leads to a decline in deposits on the order of four percent. The only other noteworthy point is that the addition of the GDP control tends to reduce the statistical significance of the Fed funds coefficients somewhat.

Overall, we draw the following two conclusions from Table 2: First, it seems clear that a contraction in monetary policy does indeed lead to a decline in core deposits for banks of all size classes. Second, it does not seem that the magnitude of this effect varies in any systematic way across size classes. Figure 1 illustrates our basic results. It plots a cumulative response of core deposits to a Fed funds shock for the two extreme size classes–BIG and SMALL 75. The responses are calculated using the coefficient estimates from the second specification (which includes the GDP control) and an orthogonalization of the vector autoregression where the shock to the funds rate is ordered last.[17]

[16]In all our tables, we work with nominal variables, and include the growth of the CPI as an additional right-hand-side variable. An alternative, slightly more restrictive specification is to work with all real variables and to omit the growth of the CPI from the equation. This yields very similar results, as we discuss below.

[17]In other words, the picture is drawn under the assumption that the Fed has information about movements in the current quarter's inflation, GDP, and deposits. In this case, the shock to the funds rate will be uncorrelated with any other disturbances in the VAR. We follow this convention in all of the subsequent figures in the paper.

Figure 1


Simulated Response of Large and Small Bank Core Deposits
Increase the Funds Rate by 100 basis points
100.0
99.9
99.8
99.7
99.6
99.5
99.4
99.3
99.2
small banks
large banks
0
1
2
3
4
5
6
7
8
quarters

5.2 *The response of bank loans to a monetary shock*

We now focus on the most direct test of our theory: is the lending volume of smaller banks more sensitive to monetary policy than the lending volume of large banks? The results are presented in Table 3. The structure of Table 3 is analogous to that of Table 2, except that the dependent variable is now the growth rate of nominal total loans in any given size category. Indeed, the first two specifications in Table 3 are exactly the same as those in Table 2: we use changes in the Fed funds rate as our monetary policy indicator, and we run the regressions both with and without an additional set of nominal GDP controls.

Table 3:
Loans Regressions
(Δ Nominal Loans is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag 1	2	3	4	Sum (t-stat)
1. BIG	ΔFed funds	ΔCPI	-0.39	.15	.55	.94	1.25 (0.79)
1. SMALL 98	ΔFed funds	ΔCPI	-1.64	-.48	-.11	.23	-2.00 (-2.05)
1. SMALL 95	ΔFed funds	ΔCPI	-1.85	-.56	-.36	.37	-2.39 (-2.54)
1. SMALL 90	ΔFed funds	ΔCPI	-1.89	-.64	-.42	.34	-2.60 (-2.62)
1. SMALL 75	ΔFed funds	ΔCPI	-1.99	-.56	-.55	.27	-2.83 (-2.74)
2. BIG	ΔFed funds	Δngdp, ΔCPI	-1.48	-.77	.18	.87	-1.20 (-0.60)
2. SMALL 98	ΔFed funds	Δngdp, ΔCPI	-1.96	-.87	-.36	.23	-2.95 (-2.42)
2. SMALL 95	ΔFed funds	Δngdp, ΔCPI	-2.15	-.88	-.49	.38	-3.15 (-2.68)
2. SMALL 90	ΔFed funds	Δngdp, ΔCPI	-2.17	-.99	-.52	.32	-3.36 (-2.68)
2. SMALL 75	ΔFed funds	Δngdp, ΔCPI	-2.29	-.90	-.61	.32	-3.48 (-2.63)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Specifications 1 and 2 are estimated by OLS, specifications 3 and 4 are estimated by IV, using lagged changes in the Fed funds rate as an instrument for the contemporaneous own-core deposits variable.

Table 3: (continued)
Loans Regressions
(Δ Nominal Loans is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag				Sum
			0	1	2	3	(t-stat)
3. BIG	Δ own-core dep.	ΔCPI	.18	-.27	.04	.02	-.03 (-.06)
3. SMALL 98	Δ own-core dep.	ΔCPI	.64	-.05	-.06	.15	.69 (2.92)
3. SMALL 95	Δ own-core dep.	ΔCPI	.77	-.03	-.08	.11	.77 (3.01)
3. SMALL 90	Δ own-core dep.	ΔCPI	.79	.00	-.15	.14	.79 (3.00)
3. SMALL 75	Δ own-core dep.	ΔCPI	.79	.09	-.19	.15	.84 (3.12)
4. BIG	Δ own-core dep.	Δngdp, ΔCPI	.95	-.30	.01	-.08	.58 (1.66)
4. SMALL 98	Δ own-core dep.	Δngdp, ΔCPI	.66	.03	-.02	.11	.78 (3.28)
4. SMALL 95	Δ own-core dep.	Δngdp, ΔCPI	.77	.05	-.04	.08	.86 (3.32)
4. SMALL 90	Δ own-core dep.	Δngdp, ΔCPI	.79	.08	-.11	.13	.90 (3.27)
4. SMALL 75	Δ own-core dep.	Δngdp, ΔCPI	.81	.16	-.17	.15	.95 (3.26)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Specifications 1 and 2 are estimated by OLS, specifications 3 and 4 are estimated by IV, using lagged changes in the Fed funds rate as an instrument for the contemporaneous own-core deposits variable.

The results uniformly support the predictions of our model. For example, in the first specification, the sum of the coefficients for the BIG category is 1.25 and is completely insignificant. The point estimate suggests that a contraction in monetary policy actually *increases* large-bank lending in the short run.[18] In contrast, the four SMALL categories have coefficients with sums that decline monotonically from -2.00 to -2.83, all of which are statistically significant.

Similar results obtain when we move to the second specification, which adds the nominal GDP control. The sum of the coefficients for the BIG category is now negative at -1.20 but still completely insignificant. The coefficients for the four SMALL categories have sums that continue to be substantially larger in absolute magnitude, ranging from -2.95 to -3.48; these sums are still strongly significant as well. Thus, an increase in the funds rate apparently has much more of a dampening effect on the lending behavior of small banks.

The table also tries two additional specifications, numbers three and four. In both of these, we use as a measure of the monetary impulse the growth in nominal core deposits for the size category in question. For example, when studying the BIG category, the key right-hand side variable is the growth in nominal core deposits for the BIG banks. So rather than using an economy-wide measure of monetary policy such as the Fed funds rate, we are now allowing each size category to have its own measure. In a sense, this sort of specification is much closer in spirit to the regressions seen in the literature on nonfinancial firms, where firms' investment is regressed on some measure of their *own* cashflow–own-core deposits can be thought of as a direct analog to own-firm cashflow.

Of course, this change in specification should not make a big difference if, as suggested by the previous Table 2, shocks to the Fed funds rate have a roughly equal-sized impact on BIG and SMALL core deposits. Nonetheless, we thought it was important to try it this way also, as a way of assessing the robustness of our results.

As before, we estimate four coefficients on the monetary impulse variable. The one minor difference is that we begin in this case with the *contemporaneous* value of the growth in own-core deposits, and then add lags one through three. We do this since it seems likely that a shock to deposits in any given quarter might have an immediate impact on loan volume and/or securities holdings. However, because the inclusion of this contemporaneous deposit

[18]Other recent papers (e.g., Bernanke and Blinder 1992, Romer and Romer 1990, and Christiano, Eichenbaum, and Evans 1994) have also found some tendency for certain measures of aggregate lending volume to react sluggishly or even increase in the short run in response to a monetary contraction. As will become clear, our work suggests that this is primarily due to the behavior of the largest banks.

term could in principle lead to a simultaneity bias, we run the regressions using instrumental variables, with four lags of the change in the Fed funds rate serving as an instrument for the contemporaneous deposit term.[19]

The results from specifications three and four echo those from the earlier ones. The sum of the coefficients on the own-core deposits variable is substantially higher for banks in the SMALL categories. For example, in specification three, the sum of the coefficients for the BIG banks is -.03 and completely insignificant. For the SMALL bank categories, the sum ranges from .69 to .84, all of which are strongly significant. In specification four, which adds the nominal GDP control, the sum of the coefficients for BIG banks rises to .58, but is still not statistically significant. Meanwhile, the sum for the SMALL banks ranges from .78 to .95, all of which are again strongly significant.

Overall, we read the results in Table 3 as providing quite strong support for the model's predictions regarding loan volume. Figure 2 provides an illustration of these results, plotting the cumulative impulse response of loans to a shock in the funds rate for the extreme size categories. (As in Figure 1, we use our second specification to generate the impulse response function.)

However, one possible objection is that since we are looking at *total* loans, our results may be driven in part by aggregation effects across loan categories. As was seen in Table 1, banks in the BIG category concentrate on different types of lending than the banks in some of the SMALL categories–for example, the larger banks tend to do relatively more C&I lending, and relatively less real estate lending. One troubling possibility is that what we are picking up is just differences in the demand-side behavior of these different types of loans. For example, it may be that C&I loan demand responds less to a monetary contraction than does real estate loan demand; if this is the case, we might get our results for total loan volume even if BIG and SMALL banks behaved identically *within* the C&I loan class.[20]

This possibility can be at least partially addressed by looking at the behavior of C&I loan volume rather than total loan volume. This is done in Table 4. The table is exactly the same as Table 3, except that we have replaced the total bank loans with bank C&I loans.

Overall, the table suggests that even within the C&I loan class, there are clear-cut differences across banks in the different size categories. Indeed, the

[19]We also tried rerunning the regressions with OLS. As it turns out, this changes none of our conclusions. We also find qualitatively similar results if we drop the contemporaneous deposit term altogether, but in this case the magnitudes are much smaller and the standard errors are larger.

[20]This is really nothing more than a variant of the heterogeneous loan-demand story sketched above. Gertler and Gilchrist (1993a, 1993b) present some evidence that suggests that C&I lending volume responds more sluggishly to monetary shocks than other forms of lending.

Figure 2

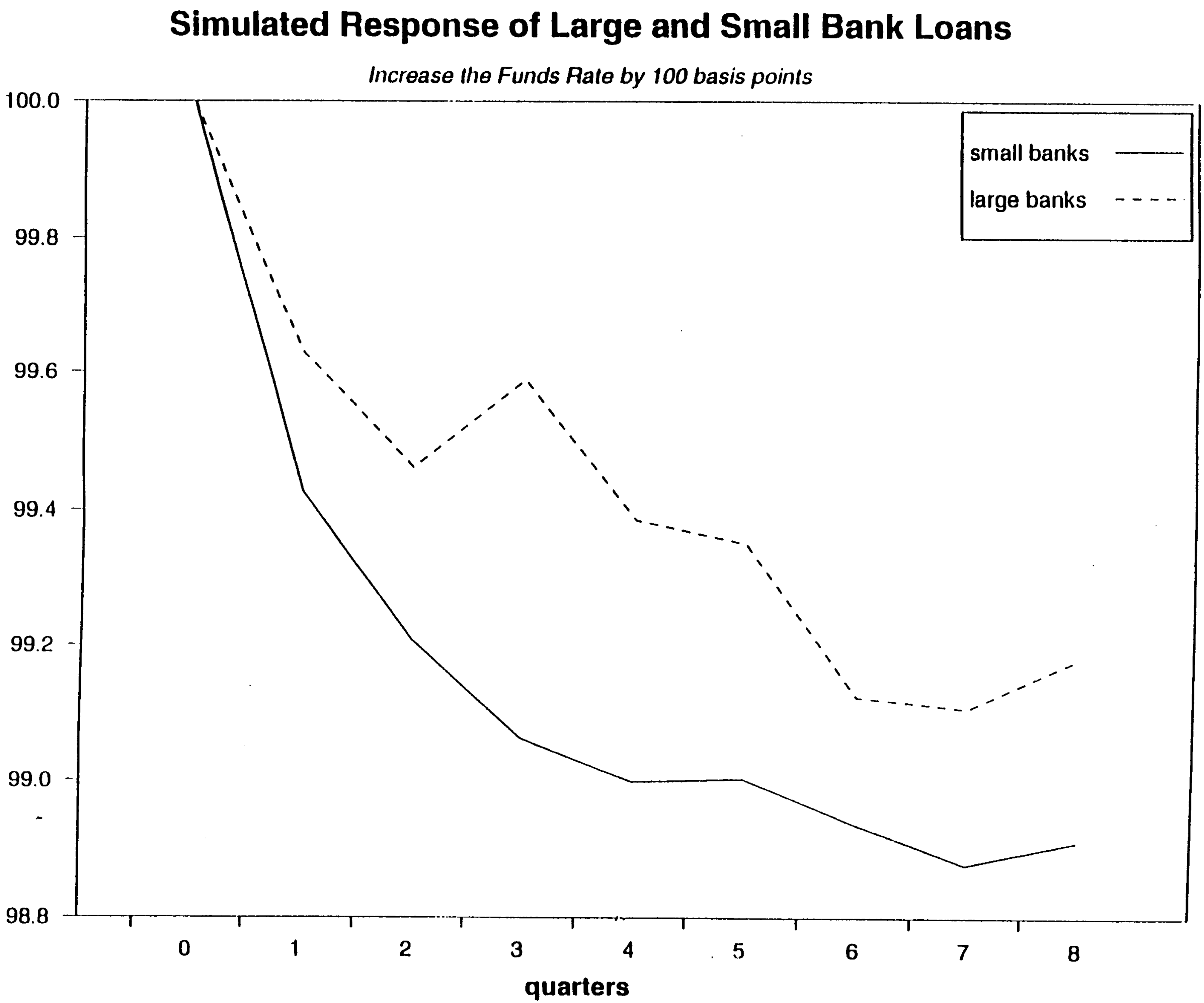

Simulated Response of Large and Small Bank Loans
Increase the Funds Rate by 100 basis points
100.0
99.8
99.6
99.4
99.2
99.0
98.8
small banks
large banks
0
1
2
3
4
5
6
7
8
quarters

Table 4:
C&I Loans Regressions
(Δ Nominal C&I Loans is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag 1	2	3	4	Sum (t-stat)
1. BIG	ΔFed funds	ΔCPI	2.72	3.41	-1.03	3.44	8.54 (0.73)
1. SMALL 98	ΔFed funds	ΔCPI	.-1.28	.33	.41	.04	-.50 (-.38)
1. SMALL 95	ΔFed funds	ΔCPI	-1.39	.36	.06	-.04	-1.01 (-.83)
1. SMALL 90	ΔFed funds	ΔCPI	.-1.71	.61	-.48	-.09	-1.67 (-1.38)
1. SMALL 75	ΔFed funds	ΔCPI	.-1.54	.31	-.53	-.04	-1.80 (-1.47)
2. BIG	ΔFed funds	Δngdp, ΔCPI	-1.42	-6.73	-2.39	8.09	-2.45 (-0.18)
2. SMALL 98	ΔFed funds	Δngdp, ΔCPI	-2.24	-.70	-.37	-.04	-3.35 (-1.78)
2. SMALL 95	ΔFed funds	Δngdp, ΔCPI	-2.27	-.47	-.47	-.12	-3.33 (-1.91)
2. SMALL 90	ΔFed funds	Δngdp, ΔCPI	-2.49	-.18	-.99	-.20	-3.86 (-2.24)
2. SMALL 75	ΔFed funds	Δngdp, ΔCPI	-2.22	-.40	-.86	-.17	-3.65 (-2.02)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Specifications 1 and 2 are estimated by OLS, specifications 3 and 4 are estimated by IV, using lagged changes in the Fed funds rate as an instrument for the contemporaneous own-core deposits variable.

Table 4: (continued)
C&I Loans Regressions
(Δ Nominal C&I Loans is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag 0	1	2	3	Sum (t-stat)
3. BIG	Δ own-core dep.	ΔCPI	-1.65	.63	.72	-1.38	-1.68 (-.46)
3. SMALL 98	Δ own-core dep.	ΔCPI	.50	-.21	-.08	.45	.66 (1.88)
3. SMALL 95	Δ own-core dep.	ΔCPI	.56	-.16	-.12	.51	.80 (2.29)
3. SMALL 90	Δ own-core dep.	ΔCPI	.61	-.13	-.13	.56	.91 (2.52)
1. SMALL 75	Δ own-core dep.	ΔCPI	.61	-.04	-.11	.48	.95 (2.56)
4. BIG	Δ own-core dep.	Δngdp, ΔCPI	2.01	-.18	.17	-1.52	.48 (.22)
4. SMALL 98	Δ own-core dep.	Δngdp, ΔCPI	.92	-.07	-.02	.41	1.24 (2.95)
4. SMALL 95	Δ own-core dep.	Δngdp, ΔCPI	.89	-.01	-.06	.50	1.31 (3.13)
4. SMALL 90	Δ own-core dep.	Δngdp, ΔCPI	.74	.00	-.11	.56	1.19 (3.07)
4. SMALL 75	Δ own-core dep.	Δngdp, ΔCPI	.70	.08	-.07	.51	1.22 (2.89)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Specifications 1 and 2 are estimated by OLS, specifications 3 and 4 are estimated by IV, using lagged changes in the Fed funds rate as an instrument for the contemporaneous own-core deposits variable.

results in Table 4 parallel those in Table 3 very closely. In each of the four regression specifications, the point estimates for the sums of the coefficients imply that loan volume is much more sensitive to monetary policy for banks in the SMALL categories than for BIG banks. Moreover, most (though not all) of the SMALL-bank regressions yield significant t-statistics. Thus, we conclude from Table 4 that our results for total loan volume in Table 3 were probably not driven by aggregation problems across different loan classes.

Interestingly, as with total loans, BIG-bank C&I loan volume actually appears to *increase* somewhat in the short run in response to a monetary contraction for two of the four specifications. Thus, to the extent that prior research has documented a tendency for aggregate measures of loan volume to respond sluggishly — or even in the "wrong" direction — to monetary policy, this would appear to be due in part to the differential behavior of large banks, and more specifically, to the differential behavior of large-bank C&I lending. (Although we should be cautious with this conjecture, since none of the results for the BIG class are even close to being statistically significant.)

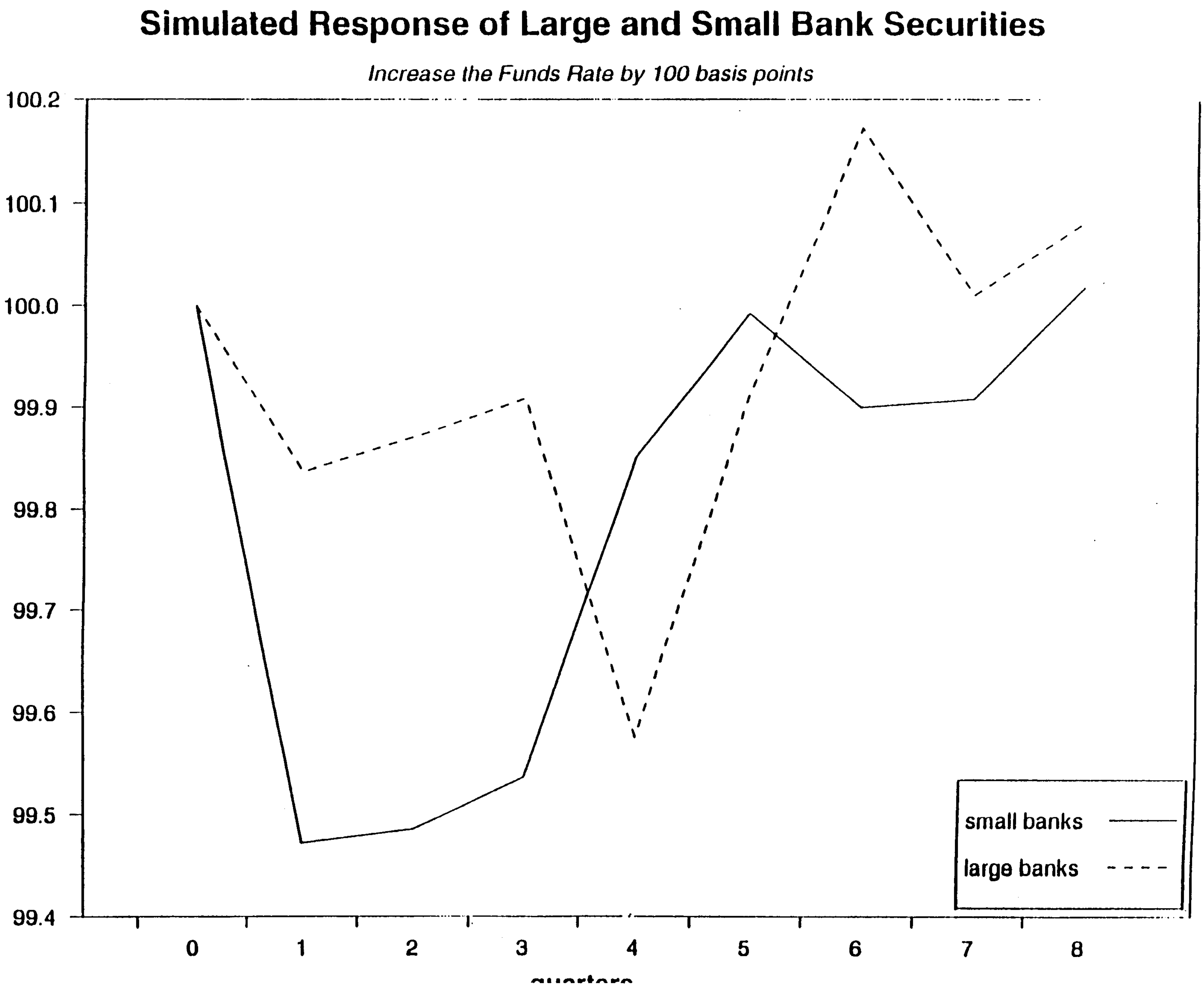
5.3 *The response of bank securities holdings to a monetary shock*

We now turn to our final, most stringent set of tests. As discussed above, the strongest evidence for our theory would be if we found that: (1) not only are SMALL-bank loans more sensitive to monetary policy; but (2) SMALL-bank securities holdings are as well. What makes this test a stringent one is that in order for us to find the evidence we are looking for, not only must our theory of loan supply effects be true, but individual banks must face relatively inelastic loan demand schedules.

Table 5 presents the evidence. The structure of Table 5 is identical to that of Tables 3 and 4. The first two specifications — those using the change in the Fed funds rate as a measure of the monetary impulse — yield results for securities holdings that parallel those for lending volume. In both cases, the point estimates suggest that SMALL-bank securities holdings are indeed more sensitive to monetary policy than BIG-bank securities holdings. Moreover, the sums of the coefficients on the funds rate are statistically significant in all the SMALL-category regressions, and are completely insignificant in the BIG-category regressions. Figure 3 provides a graphical illustration, tracing out the impulse responses for the extreme-size categories; as before, the impulse responses are computed using our second specification.

The results from the third and fourth specifications are more ambiguous. In the third specification, the point estimates suggest that BIG-bank securities holdings are actually more sensitive, although the standard errors for the BIG category continue to be quite large. In the fourth specification, the comparison is reversed, so that SMALL-bank securities holdings again

Figure 3



Simulated Response of Large and Small Bank Securities
Increase the Funds Rate by 100 basis points
100.2
100.1
100.0
99.9
99.8
99.7
99.6
99.5
99.4
0
1
2
3
4
5
6
7
8
small banks
large banks

Table 5:
Cash and Securities Regressions
(Δ Nominal Cash & Securities is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag 1	2	3	4	Sum (t-stat)
1. BIG	ΔFed funds	ΔCPI	-.65	-.11	-.32	-1.77	-2.85 (-.85)
1. SMALL 98	ΔFed funds	ΔCPI	-2.16	-1.56	-1.74	-.39	-5.85 (-3.42)
1. SMALL 95	ΔFed funds	ΔCPI	-2.22	-1.66	-1.79	-.31	-5.99 (-3.41)
1. SMALL 90	ΔFed funds	ΔCPI	-2.13	-1.61	-1.82	-.32	-5.88 (-3.38)
1. SMALL 75	ΔFed funds	ΔCPI	-1.99	-1.44	-1.90	-.44	-5.77 (-3.39)
2. BIG	ΔFed funds	Δngdp, ΔCPI	-.65	.33	1.18	-1.15	-.29 (-.06)
2. SMALL 98	ΔFed funds	Δngdp, ΔCPI	-2.24	-.63	-.95	.07	-3.75 (-1.90)
2. SMALL 95	ΔFed funds	Δngdp, ΔCPI	-2.31	-.61	-.94	.19	-3.67 (-1.83)
2. SMALL 90	ΔFed funds	Δngdp, ΔCPI	-2.20	-.55	-1.01	.12	-3.64 (-1.81)
2. SMALL 75	ΔFed funds	Δngdp, ΔCPI	-2.11	-.44	-1.11	-.07	-3.73 (-1.81)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Specifications 1 and 2 are estimated by OLS, specifications 3 and 4 are estimated by IV, using lagged changes in the Fed funds rate as an instrument for the contemporaneous own-core deposits variable.

Table 5 (continued)
Cash and Securities Regressions
(Δ NominalCash & Securities is Dependent Variable)

Specification	Measure of Monetary Impulse	Other r.h.s. Variables*	Coefficients on Monetary Impulse at Lag				Sum
			0	1	2	3	(t-stat)
3. BIG	Δ own-core dep.	ΔCPI	1.93	-.22	-.07	-.23	1.41 (1.64)
3. SMALL 98	Δ own-core dep.	ΔCPI	.89	-.14	.12	-.18	.68 (2.76)
3. SMALL 95	Δ own-core dep.	ΔCPI	.94	-.18	.21	-.22	.74 (2.67)
3. SMALL 90	Δ own-core dep.	ΔCPI	.91	-.15	.21	-.21	.77 (2.58)
3. SMALL 75	Δ own-core dep.	ΔCPI	.90	-.12	.26	-.27	.76 (2.48)
4. BIG	Δ own-core dep.	Δngdp, ΔCPI	.91	-.15	-.24	.07	.59 (.97)
4. SMALL 98	Δ own-core dep.	Δngdp, ΔCPI	.81	-.03	.17	-.05	.90 (3.70)
4. SMALL 95	Δ own-core dep.	Δngdp, ΔCPI	.86	-.07	.26	-.07	.99 (3.67)
4. SMALL 90	Δ own-core dep.	Δngdp, ΔCPI	.84	-.05	.29	-.05	1.02 (3.59)
4. SMALL 75	Δ own-core dep.	Δngdp, ΔCPI	.83	-.07	.36	-.12	1.00 (3.32)

*All specifications also include four lags of the dependent variable, four quarterly dummies, and a dummy corresponding to a 1984 Q1 change in certain data definitions. Specifications 1 and 2 are estimated by OLS, specifications 3 and 4 are estimated by IV, using lagged changes in the Fed funds rate as an instrument for the contemporaneous own-core deposits variable.

appear to be more sensitive.

On balance, the evidence in Table 5 would appear to favor the notion that SMALL-bank securities holdings are in fact more sensitive to monetary policy than BIG-bank securities holdings. However, this conclusion is a tentative one; the results for securities holdings are not as clear-cut as they were for lending volume.

Even if the results are not totally decisive in favor of the proposition that SMALL-bank securities holdings are more sensitive to monetary policy, there is also no real evidence to support the converse proposition–that SMALL-bank securities holdings are *less* sensitive to monetary policy. This is an important point. If our earlier lending volume results are to be explained away by an alternative hypothesis based on heterogeneous loan demand, that alternative hypothesis would also unambiguously predict that SMALL-bank securities holdings would be less sensitive to monetary policy.[21] Since we do not find this to be the case, we must conclude that there is no positive evidence in favor of the alternative hypothesis.

In contrast, our theory does not tie down the relative sensitivity of SMALL- and BIG-bank securities holdings–recall that this comparison turns on the elasticity of loan demand. Therefore, even if the empirical results for securities holdings are interpreted as a dead heat between SMALL- and BIG banks, this would seem to be more damaging to the heterogeneous loan-demand alternative hypothesis than to our theory.

5.4 *Robustness checks*

In addition to the specifications reported in the tables, we tried a number of other alternatives to ensure the robustness of our results. A brief summary is as follows.

Romer dates as an alternative indicator of monetary policy. We reran all the regressions corresponding to our first two specifications, substituting a "Romer dummy" variable for the change in the Fed funds rate as our measure of the monetary impulse. We did so in large part to be consistent with much recent work (including our own) that has used the Romer and Romer (1989) dates as an indicator of monetary policy. Unfortunately, in this case, our shorter time series only includes three such dates. Moreover, two of these dates — the August 1978 and the October 1979 ones — are sufficiently close to each other that they cannot really be considered independent observations. The bottom line is that one should probably expect any regressions using

[21]To remind the reader of the intuition: if smaller banks' loan volume goes down by more in the wake of a monetary contraction, and if this is due to a disproportionate decline in the loan demand facing small banks, then one should expect small banks to shift their portfolios towards securities. Thus, small banks would, under the alternative hypothesis, cut securities by *less* in response to a monetary shock.

Romer dates in our sample to be extremely noisy. Indeed, this is what happens–many of the estimated coefficients are far from being statistically significant.

Nonetheless, it is interesting to note that if one just looks at the point estimates for the sums of the coefficients, they all tell the same story: total loans, C&I loans, and securities all are cut more by SMALL banks than by BIG banks in the wake of a Romer date. This is true both for the specifications that include a nominal GDP control and those that do not. Thus, while the results may not be precise, they all go in the direction of supporting our theory.

Cutting off the sample in 1989 because of the "capital crunch". We also redid all the tables completely, with the sample period ending in 1989 Q1 rather than in 1992 Q2. We did so because of a concern that our conclusions might be affected by the so-called "capital crunch" that arose as capital-deficient banks struggled to meet the new Basle standards that were being phased in through 1992. [See, e.g., Bernanke and Lown (1991) for a discussion.] If the capital crunch did indeed affect bank portfolio behavior, and if these effects varied systematically across size classes — as well they might, since smaller banks are systematically better capitalized — then our regression results could conceivably be affected.

As it turns out, however, truncating the sample period in this way does not markedly affect our results. For total loans and C&I loans, we still find that SMALL banks react more sensitively than BIG banks to changes in the stance of monetary policy for every one of our specifications. Indeed, in most specifications, the parameter estimates are almost identical to those shown in Tables 3 and 4. When this is not the case, the differential between SMALL and BIG banks actually appears to be slightly *more* pronounced when we use the shorter sample period. Thus, it seems clear that our results for total loans and C&I loans are not in any way driven by capital-crunch effects.

The one specification where changing the sample period makes a noteworthy difference is in the second specification for securities holdings. Using this specification in the longer sample period, we saw in Table 5 that SMALL banks appeared to cut securities by more than BIG banks in response to a monetary shock; moreover, the sum of the coefficients on the funds rate for SMALL banks was (marginally) statistically significant. This result disappears when we truncate the sample in 1989. Now the sum of the coefficients for SMALL banks falls below that for BIG banks and becomes completely insignificant. Thus, if we focus on the shorter sample period, the results for securities become overall very ambiguous–it is hard to conclude that there are clear-cut patterns in any direction.

Real, rather than nominal specifications. Finally, we also redid all the tables, using real, rather than nominal values of deposits, loans, securities, and GDP, and omitting the CPI terms from the regressions. This can be thought of as a slightly more constrained variant of the specifications described above. The findings here parallel those from our previous robustness check with the foreshortened sample. In particular, the results for total loans and C&I loans are impervious to the change in specification; every regression continues to show that SMALL banks' lending volume is more sensitive to monetary policy than that of BIG banks. The results for securities holdings, on the other hand, again seem to be somewhat more sensitive to the specification used–now three out of the four regressions actually show securities being more sensitive for BIG banks. This is essentially the opposite of what we found in Table 5.

The bottom line from our various robustness tests is this: the results for total loans and C&I loans appear to be extremely robust. In contrast, the results for securities holdings appear to be more sensitive to the specification used. When combined with the fact that our baseline results for securities in Table 5 were already less than completely clear-cut, this leads us to conclude that it is hard to say anything confidently about the relative sensitivity of SMALL- and BIG-bank security holdings.

Again, however, it is important to keep the ambiguous results for securities holdings in perspective. While they may not allow us to decisively reject the heterogeneous-loan-demand alternative explanation for our loan volume results, they also do not provide any positive support for this alternative explanation, either. Moreover, the ambiguous results for securities are also completely consistent with a version of our theory in which loan demand is relatively elastic.

6 Summary and conclusions

The basic theme of this paper has been that banking firms may be subject to the same sort of capital market imperfections as their nonfinancial counterparts. One implication of this view is that monetary policy will work in part through a lending channel: when the Fed drains deposits from the system, banks cannot frictionlessly make up the funding shortfall by raising nondeposit external finance. Consequently, their lending behavior is affected, and so in turn is the investment spending of those nonfinancial firms that rely on banks for funding.

Overall, we interpret our empirical evidence as being clearly consistent with this story. At the same time, we recognize some of its limitations. Given the level of disaggregation and the relatively short time series that we were working with, our tests were not as powerful as one might have liked. Thus, while the point estimates tend to line up with the predictions of our theory, the statistical significance is not always overwhelming.

The natural next step is to further disaggregate the data, in an effort to increase the power of the tests. For example, we could use the Call-Report data to perform individual bank-level regressions that are similar in spirit to our size-category regressions. In addition to increasing the precision of our estimates, this would allow us to control much more carefully for a number of other factors that might affect individual banks' ability to make loans–e.g., their capital ratios, etc. We plan to attempt this in future work; at the very least, the results in this paper are sufficiently encouraging to make such further work worthwhile.

Data Appendix

Throughout the analysis our size categories are formed by sorting the banks on the basis of their total assets–call report item rcfd2170. We construct four main series from the call reports that are used in the empirical work. As mentioned in the text, most of the series in the call reports were defined differently before and after March of 1984, so most of our series must be spliced in the first quarter of 1984.

The data for total loans after March 1984 come from item rcfd2125 in the call reports. This series is defined as "loans and leases net of unearned income, allowance and reserve." In March of 1984, the series was changed to include lease-financing receivables, therefore prior to March 1984 rcfd2125 and rcfd2165 (lease-financing receivables) must be summed to insure comparability. Starting in March 1984, transfer risk reserve is also being netted out. Prior to that time this type of adjustment does not appear to have existed, so there is no way to avoid a slight discontinuity.

The data for commercial and industrial loans after March 1984 come from item rcfd1766. Prior to March 1984 we use item rcfd1600. Unfortunately, rcfd1600 includes some bankers' acceptances that are not included in rcfd1766, but there is no way to make the two series comparable because the relevant acceptance numbers are never separately reported.

The data for securities after March 1984 are taken from item rcfd0390. The definition of this series was changed in March 1984 to include holdings of corporate stock. This redefinition causes a discontinuity because prior to 1984 it is not possible to separately add up all of the items that are now included item rcfd0390. As an approximation we sum items rcfd0400 (U.S. Treasury Securities), rcfd0600 (U.S. Government Agency and Corporate Obligations), rcfd0900 (Obligations of States and Political Subdivisions), and rcfd0380 to get a comparable series. The data on securities is added to data on cash holdings (item rcfd0010) to get an overall series for cash and securities.

Finally, we construct estimates of small deposits. This series is constructed by removing large deposits (the sum of item rcon6645, certificates of deposits of denominations above $100,000, and item rcon6646, open time deposits of over $100,000) from total deposits (item rcfd2200). Detailed information on deposits is generally only available for deposits of the domestic operations of banks. So although the total deposit data may include deposits held outside the U.S. for some banks, information on large or small deposits is only available for banks domestic operations.

For the snapshot of the data given in Table 1, we looked at several other series. The numbers of Federal Funds sold and Securities Purchased Under Agreements to Resell come from item rcfd1350. The data on real estate loans, loans to depository institutions, agricultural loans, loans to individuals, and other loans are taken from items rcfd1410, rcfd1489, rcfd1590, rcfd1975 and rcfd2080, respectively.

Regarding the liabilities data in Table 1, the information for transactions deposits and brokered deposits comes from items rcon2215 and rcon2365, respectively. The data on Federal Funds Purchased and Securities Sold Under Agreements to Repurchase are from item rcfd2800. The numbers for equity and subordinated debt are taken from items rcfd3210 and rcfd3200. The data shown for other liabilities is constructed to assure that total assets and total liabilities balance.

The data on nominal gross domestic product, the consumer price index (not seasonally adjusted), and the Federal funds rate are variables GDP, PZUNEW, and FYFF from Citibase.

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