BANKS' LOAN PORTFOLIO AND THE MONETARY TRANSMISSION MECHANISM*

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Abstract

This paper investigates the portfolio behavior of bank loans following a monetary tightening. We find that real estate and consumer loans sharply decrease, while commercial and industrial (C&I) loans increase. We compare this behavior with the responses following non-monetary shocks, which also reduce output but keep interest rates roughly unchanged. During such a "non-monetary" downturn, C&I loans sharply decrease, while real estate and consumer loans show no substantial response. These responses, together with the responses of relevant lending rates, are hard to reconcile with a decline in the supply of C&I bank loans during a monetary downturn as stressed by the bank-lending channel. Instead, we give several arguments why the supply of C&I loans may actually increase after a monetary contraction.

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1 Introduction

The empirical properties of the monetary transmission mechanism are often characterized using impulse response functions of an estimated vector autoregressive system (VAR). The federal funds rate, a price index, and a measure for real activity are almost always included, but other variables have also been considered.[1] To estimate the parameters efficiently, however, one cannot include too many variables in the VAR. Empirical studies, therefore, typically only include comprehensive variables such as GDP and total loans and do not include all the separate micro components that comprise the comprehensive variable. However, if the micro components of a variable have different laws of motion, then the impulse response function of the aggregated variable may hide useful information about the role that these micro components play in the monetary transmission mechanism.

We find this to be relevant in our analysis of the behavior of total bank loans and its components (commercial and industrial (C&I) loans, real estate loans, and consumer loans) after a monetary tightening. That is, the estimated responses for total loans are not robust and typically are not significant. Based on this a researcher may conclude that bank loans do not play an important role in the monetary transmission mechanism. This would be the wrong conclusion, however, because we find an intriguing set of heterogeneous responses for the bank loan components that are both robust and significant.

It has already been recognized in the literature that determining what bank loans do after a monetary tightening is not as easy as one might think. Gertler and Gilchrist (1993b) summarize this as follows:

> "Conventional wisdom holds that tightening of monetary policy should reduce bank lending. It is surprisingly difficult, however, to find convincing time series evidence to support this basic prediction of macroeconomic theory".

This paper adds to the literature on the role of bank lending during the monetary transmission mechanism by doing the following. First, we analyze the behavior of the three main loan components following a monetary policy shock and establish robust responses. Second, we analyze the responses of bank equity. Third, we not only consider the behavior of financial variables after a monetary tightening, but also document the behavior of the loan components after negative non-monetary shocks. That is, we compare the behavior of the loan components during a monetary downturn—when interest rates display a sharp increase and output is low—with the

[1] See Christiano, Eichenbaum, and Evans (1999) for an excellent overview.

behavior during a non-monetary downturn—when output is low and interest rates display a moderate decrease. By comparing the behavior of the different forms of lending and bank equity after the two types of shocks we can gain useful insights into the workings of the monetary transmission mechanism.

Our main results are the following:[2]

- After a monetary tightening, bank loan components behave quite differently from one another. In particular, real estate and consumer loans display significant declines, while the responses of C&I loans are positive and often significant.[3]

- In contrast, during a non-monetary downturn C&I loans display a sharp decrease, while real estate loans and consumer loans display either a moderate decrease or no decrease.

- Bank equity drops significantly during a monetary tightening but not during a non-monetary tightening.

Bernanke and Gertler (1995) point out that the "perverse" response of C&I loans could be consistent with a reduction in the supply of C&I loans, as predicted by the bank-lending channel theory, as long as the demand for C&I loans increases by more than the reduction in the supply. For example, firms might increase their demand for loans to finance an increase in inventories or a reduction in the utilization of their work force. We control for the behavior of inventories and also consider the responses of relevant lending rates. We argue that the explanation by Bernanke and Gertler (1995) is difficult to reconcile with our empirical findings.

As an alternative we propose the hypothesis that after a monetary tightening—when interest rates are high and economic activity is low—banks prefer to invest in short-term assets, such as C&I loans, that earn a high return (because short-term interest rates are high) and are relatively safe, than invest in long-term and risky assets such as real estate loans. We show that the behavior of mortgage rates is consistent with such a shift in the supply of real estate loans. Moreover, the substitution out of long-term and risky assets and into C&I loans makes it possible that the supply of C&I loans increases even if deposits decrease. The reasons we discuss for the change in the desired loan portfolio are related to hedging and safeguarding

[2]Later in the paper we will be more precise about what we mean by a monetary and a non-monetary downturn and how comparable they are.

[3]This is consistent with the results in Gertler and Gilchrist (1993a) and Kashyap and Stein (1995) who document that C&I loans behave differently than total loans after a monetary tightening.

the capital adequacy ratio. The portfolio behavior of banks has received very little attention in the literature on the monetary transmission mechanism and the results in this paper make clear that this omission may severely limit our understanding of the role played by banks during a monetary tightening.

The rest of this paper is organized as follows. Section 2 discusses the data used and the empirical methodology. Section 3 documents the behavior of loan components after an unexpected monetary tightening as well as negative non-monetary shocks. In Section 4 we interpret the results. The last section concludes.

2 Data sources and empirical methodology

In Section 2.1 we discuss the data employed in our study. Section 2.2 contains a discussion of our empirical methods.

2.1 Data sources

Our empirical study uses the bank loan series from the Consolidated Reports of Condition and Income (Call Reports) together with the federal funds rate, the consumer price index, and personal income from the Bureau of Economic Analysis (BEA).[4] This sample starts in the first quarter of 1977 and ends in the second quarter of 2004. We also consider results based on the data set comprised of monthly (seasonally adjusted) bank loan data for all commercial banks from the H8 data set together with the federal funds rate, the consumer price index, and industrial production.[5] This sample begins in January 1960 and ends in February 2003. A disadvantage of the H8 data is that they are based on *voluntary* bank credit reports submitted to the Federal Reserve. Since the reports are voluntary the data are based on only a sample of US banks, and are therefore, "blown up" to represent the entire universe. Since all federally-insured banks[6] are required to submit quarterly income-statement and balance-sheet data one can expect the Call Reports to be of higher quality than the H8 data.

[4] We use the income measure from the BEA because it is also available at the state level and we consider regional models in our related work.

[5] In Den Haan, Sumner, and Yamashiro (2005), we document that the results for these two data sets are very similar, even though the data are sampled at different frequencies and the sample periods differ. Therefore, to save space we only report the results using the data from the Call reports.

[6] The data cover banks regulated by the Federal Reserve System, the FDIC, and the Comptroller of the Currency.

A drawback of the Call Reports, however, is that constructing consistent time series is not trivial. The main reason is that these reports are primarily designed for regulatory purposes. Consequently, as the banking sector evolves and regulations change, what is reported and how variables are measured also changes—posing a major challenge to the effort of constructing consistent time series. Den Haan, Sumner, and Yamashiro (2002) describe details on how this challenge can be overcome.

2.2 Empirical methodology

In Sections 2.2.1 and 2.2.2 we show how we estimate the behavior of the variables following monetary and non-monetary shocks, respectively.

2.2.1 Monetary downturn

The standard procedure to study the impact of monetary policy on economic variables is to estimate a structural VAR using a limited set of variables. Consider the following VAR:[7]

$$Z_t = B_1 Z_{t-1} + \cdots + B_q Z_{t-q} + u_t, \tag{1}$$

where $Z_t' = [X_{1t}', r_t, X_{2t}']$, X_{1t} is a $(k_1 \times 1)$ vector with elements whose contemporaneous values are in the information set of the central bank, r_t is the federal funds rate, X_{2t} is a $(k_2 \times 1)$ vector with elements whose contemporaneous values are not in the information set of the central bank, and u_t is a $(k \times 1)$ vector of residual terms with $k = k_1 + 1 + k_2$. We assume that all lagged values are in the information set of the central bank. In order to proceed one has to assume that there is a relationship between the reduced-form error terms, u_t, and the fundamental or structural shocks to the economy, ε_t. We assume that this relationship is given by:

$$u_t = \overline{A}\varepsilon_t, \tag{2}$$

where $\overline{A}$ is a $(k \times k)$ matrix of coefficients and ε_t is a $(k \times 1)$ vector of fundamental uncorrelated shocks, each with a unit standard deviation. Thus,

$$E\left[u_t u_t'\right] = \overline{A}\,\overline{A}'. \tag{3}$$

When we replace $\mathrm{E}[u_t u_t']$ by its sample analogue, we obtain $n(n+1)/2$ conditions on the coefficients in $\overline{A}$. Since $\overline{A}$ has n^2 elements, $n(n-1)/2$ additional restrictions are needed to estimate all elements of $\overline{A}$. A standard practice is to obtain the

[7] To simplify the discussion we do not display constants, trend terms, or seasonal dummies that also may be included.

additional $n(n-1)/2$ restrictions by assuming that $\overline{A}$ is a lower-triangular matrix. Christiano, Eichenbaum, and Evans (1999), however, show that to determine the effects of a monetary policy shock one can work with the less-restrictive assumption that $\overline{A}$ has the following *block*-triangular structure:

$$\overline{A} = \begin{bmatrix} \overline{A}_{11} & 0_{k_1 \times 1} & 0_{k_1 \times k_2} \\ \overline{A}_{21} & \overline{A}_{22} & 0_{1 \times k_2} \\ \overline{A}_{31} & \overline{A}_{32} & \overline{A}_{33} \end{bmatrix} \tag{4}$$

where $\overline{A}_{11}$ is a $(k_1 \times k_1)$ matrix, $\overline{A}_{21}$ is a $(1 \times k_1)$ matrix, $\overline{A}_{31}$ is a $(k_2 \times k_1)$ matrix, $\overline{A}_{22}$ is a (1×1) matrix, $\overline{A}_{32}$ is a $(k_2 \times 1)$ matrix, $\overline{A}_{33}$ is a $(k_2 \times k_2)$ matrix, and $0_{i \times j}$ is a $(i \times j)$ matrix with zero elements. Note that this structure is consistent with the assumption made above about the information set of the central bank.

We follow Bernanke and Blinder (1992) and many others by assuming that the federal funds rate is the relevant monetary instrument and that innovations in the federal funds rate represent innovations in monetary policy. Our benchmark specification is based on the assumption that X_{1t} is empty and that all other elements are, thus, in X_{2t}. Intuitively, X_{1t} being empty means that the Board of Governors of the Federal Reserve (FED) does not respond to contemporaneous innovations in any of the variables of the system. For monthly data, an identification based on the exclusion of contemporaneous effects seems plausible. For quarterly data, the appropriate identification assumption is less clear.[8] Therefore, we also consider the alternative assumption that X_{2t} is empty and that all other elements are, thus, in X_{1t}. In this case, the assumption is that the FED does respond to contemporaneous innovations in all of the variables of the system.

2.2.2 Non-monetary downturn

In this paper, we compare the behavior of variables after an unexpected monetary tightening with the behavior after an unexpected negative non-monetary or "output" shock. To identify the "output" shock, we consider two identification schemes. For the first identification scheme considered, the structural shock is simply the innovation to output from the reduced-form VAR, but even for the other identification scheme it is a substantial part of this reduced-form residual. For our purpose it is not that important to interpret the nature of this structural shock. The two key features that are important for our purpose are that this shock decreases real activity *and* does not affect interest rates very much. Because of the latter property it clearly

[8] The FED is likely to respond to contemporaneous information within the quarter. Our data, however, are not real-time data, which means that the period t observation may have been revised based on information available only after period t.

distinguishes itself from a monetary shock. In addition, we compare the behavior of variables during a monetary downturn to their behavior during a downturn of equal magnitude caused by these structural output shocks. We will refer to this as a non-monetary downturn. To be more precise, a non-monetary downturn is caused by a sequence of output shocks such that output follows the exact same path as it does during a monetary downturn. The construction of a non-monetary downturn makes it convenient to quantitatively compare the responses, but the responses of the loan components following a single output shock tell a story that is very similar to that implied by the responses of loan components during a non-monetary downturn (that is, following a sequence of output shocks).

Implementing these exercises requires us to make an additional assumption on $\overline{A}$. In particular, for our benchmark specification, which assumes that $X_{1,t}$ is empty, we assume that this non-monetary shock only has a contemporaneous effect on real activity and not on any of the other variables.[9] Under this assumption, there is a simple way to calculate the impulse response functions for a non-monetary downturn. In each period we simply set the value of aggregate real activity equal to the value observed during the monetary downturn, and then obtain values for the remaining variables by iterating on the VAR.[10] If the two downturns are comparable, then one can interpret the difference between the impulse response functions as the effect of the increase in the interest rate holding real activity constant.[11] For our alternative identification scheme, which assumes that $X_{2,t}$ is empty, we assume that only the non-monetary shock affects real activity. For this identification scheme we explicitly back out the sequence of structural shocks and then calculate the implied impulse response functions.

The motivation for looking at the responses to non-monetary shocks is the following. The impulse response functions for the monetary downturn not only reflects the direct responses of the variables to an increase in the interest rate, but also the indirect responses to changes in the other variables, and, in particular, to the decline in real activity. This makes it difficult to understand what is going on, especially since a decline in real activity could increase or decrease the demand for

[9] That is, the matrix $\overline{A}_{33}$ also has a block-triangular structure. Note that the block-triangular structure imposed in Equation 4 already made the assumption that no structural shock except the monetary shock could have an effect on the federal funds rate.

[10] The assumption that the non-monetary shock does not affect the other variables contemporaneously implies that we do not have to explicitly calculate the values of the structural shock during a non-monetary downturn.

[11] In fact, the difference between these two impulse response functions is equal to the response to a shock in the federal funds rate when the response of the real income variable is set equal to zero in every period.

bank loans.[12] For example, if one observes an increase in a loan component during a monetary downturn it could still be the case that there is a credit crunch, if a decline in real activity strongly increases the demand for that loan component. Without the credit crunch this loan component would have increased even more. By comparing the behavior of loan components during a monetary downturn with a non-monetary downturn of equal magnitude one can get an idea regarding the importance of the different effects of the higher interest rate. Obviously, there are some pitfalls to this comparison but we think that they provide a useful set of contrasting empirical results even if the two downturns are different in nature.

We extend our analysis by including inventories in the VAR. In particular, we construct a non-monetary downturn during which the behavior of both real income and inventories is identical to that observed during a monetary downturn, but is caused by two non-monetary shocks, a structural output and a structural inventory shock.[13]

3 Results

The first subsection focuses on the behavior of the loan components after a monetary tightening and compares this behavior with the responses observed after non-monetary shocks. The second subsection documents the behavior of several key interest rates and bank equity.

3.1 Loan component responses

The results discussed in this subsection are based on a VAR that includes the three loan components, the federal funds rate, a price index, and a real activity measure. The benchmark specifications for the VARs include one year of lagged variables, a constant, and a linear trend. We also use quarterly dummies since the Call Report data are not adjusted for seasonality.

In addition, we estimate a VAR for which the specification is chosen using the Bayes Information Criterion (BIC). We search for the best model among a set of models that allows as regressors the variables mentioned above and a quadratic deterministic trend. BIC chooses a specification that is much more concise then our benchmark specification. In Den Haan, Sumner, and Yamashiro (2005), we

[12] On one hand the reduction in real activity would reduce investment and, thus, the need for loans, while on the other hand the reduction in sales would increase inventories, which could increase the demand for loans.

[13] We assume that the two non-monetary shocks only affect real income and inventories contemporaneously.

document that the results are similar to those obtained from our benchmark specification. Because of the similarity we will only report the results for the benchmark specification in the main text of the paper.

Figure 1 plots the responses of output, the federal funds rate, and the price level after a one-standard-deviation shock to the federal funds rate. The results correspond to those found in the literature. After a delay of several quarters the output response is significantly negative and it takes several years for the response of output to return to zero. The federal funds rate initially shoots up by roughly eighty basis points. It gradually returns to zero but is still significantly different from zero after one year. The behavior of the price level suffers from the price puzzle.[14]

In Panel A of Figure 2 we plot the responses of the three loan components after a positive innovation in the federal funds rate. C&I loans display a substantial and frequently significant positive response, whereas real estate and consumer loans decline (also significant). This graph is based on the assumption that the monetary authority does not respond to contemporaneous information. The results in Figure 3 are based on the assumption that the FED can respond to contemporaneous information contained in any of the other variables in the VAR. The figure documents that the results are robust to changes in the identification assumption.

To shed some light on the question of how the downturn in real activity affects the loan components we also analyze the responses of the three loan components after a negative non-monetary or output shock. Again we consider two different identification schemes. The results reported in Panel B of Figure 2 are based on the assumption that the non-monetary shock affects only real activity contemporaneously, whereas the results in Panel B of Figure 3 are based on the assumption that the non-monetary shock is allowed to affect all other variables contemporaneously. Again, the results do not depend on the identification assumption. The results show

[14] Christiano, Eichenbaum, Evans (1999) find that adding an index for sensitive commodity prices solves the price puzzle in their sample but we find that this does not resolve the puzzle for our more recent samples. We also tried the measure of monetary policy shocks proposed by Romer and Romer (2004) and reestimated the VAR over the period for which this measure is available (1977 - 1996). In Den Haan, Sumner, and Yamashiro (2005) we show that the price level still sharply increases during the first two quarters, but after roughly one year returns to its original level after which it hovers around zero. Although not a solution to the price puzzle, it delivers a response closer to the traditional view of the monetary transmission mechanism. The responses for the loan components are remarkably robust when we use this alternative measure. In fact, even excluding the price level from the VAR does not affect the results. Barth and Ramey (2001) and Gaiotti and Secchi (2004) argue that, through a cost channel, increases in the interest rate could actually lead to an increase in the price level. We have chosen to stick to the standard specification, since the results do not seem to depend on the response of the price level, since there are reasons to believe the price level should increase after a monetary tightening, and since most VAR specifications do lead to an increase in the price level.

that after a negative non-monetary shock C&I loans display a sharp and significant decline, whereas the responses of the other two loan components are insignificant and are positive for numerous periods in the five years following a monetary tightening.

The last panel in Figures 2 and 3 document the behavior of the loan components during a non-monetary downturn. These graphs make clear that real estate and consumer loans behave according to the standard bank-lending channel. That is, during a downturn caused by a monetary tightening there is a decrease in bank lending that cannot be explained by the decrease in real activity. The results for C&I loans are clearly different. Not only do C&I loans increase during a monetary downturn, but this increase stands in sharp contrast to the substantial decrease observed during a non-monetary downturn.

Sumner (2003) shows that the behavior of the loan components after a positive innovation to the oil price is similar to the responses found here for a structural output shock. C&I loans, thus, seem to follow any decline in real activity quite closely, *except* when the change in real activity goes together with a substantial increase in interest rates, in which case, C&I loans and real activity move oppositely.

It is possible that C&I loans increase during a monetary downturn because an increase in inventories leads to an increased demand for C&I loans. Such an increase in inventories is not part of the non-monetary downturn we constructed. We, therefore, extend our analysis by adding inventories to the VAR. Consistent with the results in Bernanke and Gertler (1995), we find that after a monetary tightening inventories display a temporary increase followed by a reduction. There is no evidence, however, that this increase in inventories is the cause of the increase in C&I loans. In particular, we find that inventory shocks (either one single innovation or a sequence of shocks constructed to mimic the behavior of inventories after a monetary tightening) do not lead to an increase in C&I loans.[15] This is documented in Figure 4 in which we plot the behavior of C&I loans during a monetary downturn (but now estimated with a VAR that also includes inventories) and the behavior of C&I loans during a non-monetary downturn, during which the responses of both real activity and inventories are identical to those observed during a monetary downturn.[16]

[15] The only exception was found with the specification that does not include any real activity measure in the VAR. Even for this specification the increase in C&I loans during a non-monetary downturn (which in this case is a series of inventory shocks to match the response of inventories during a monetary tightening) was much smaller than the increase observed during a monetary downturn.

[16] The benchmark identification assumption is used.

3.2 Interest rates and bank equity

Before we give an interpretation of the empirical findings, we report the behavior of several interest rates and bank equity during a monetary downturn. Figure 5 plots the behavior of the federal funds rate, the rate on C&I loans, the rate on 24-month personal loans, the rate on 30-year fixed mortgages, and the yield on 10-year treasury bonds in response to a one-standard-deviation shock to the federal funds rate.[17] The figure shows that C&I loans follow the behavior of the federal funds rate quite closely, although in the first period its response is nineteen basis points less than the response of the federal funds rate and in the second period it is ten basis points more. Since C&I loans tend to be short-term loans one would expect them to follow the federal funds rate, but it is somewhat surprising that there is no noticeable increase in the risk premium.

The rate on short-term consumer loans is much less sensitive to the increase in the interest rate. The initial response of the rate on consumer loans is clearly less than the response predicted by the expectations hypothesis, but the response after four quarters does exceed the response predicted by the expectations hypothesis theory by a small amount. It has been pointed out in the literature that rates on consumer loans are sticky. For example, Calem and Mester (1995) highlight that between May 1989 and November 1991 the prime rate dropped from 11.5 percent to 7.5 percent, but during this period credit-card rates of the largest issuers were held fixed at 18-20 percent. Brito and Hartley (1995) provide theoretical arguments why credit-card interest rates are not likely to be responsive to changes in the cost of funds.[18] Similarly, Calem and Mester (1995) argue that credit-card rates are sticky because (i) consumers face search and switching costs and (ii) banks face an adverse-selection problem if they unilaterally reduce interest rates.

Both the response of the 30-year mortgage rate and the response of the 10-year treasury bond rate far exceed the responses predicted by the expectations hypothesis. We argue in the next section that the behavior of these interest rates provide important information for the interpretation of the results.

Finally, we report in Figure 6 the behavior of bank equity following a monetary tightening. The figure shows that in response to a monetary tightening there is a substantial and significant reduction in bank equity. Moreover, in response to the series of output shocks there is no such decline. Consequently, bank equity

[17] The VAR contained these five lending rates and real personal income. We use the identification scheme in which an innovation to the federal funds rate is allowed to affect all variables contemporaneously.

[18] They point out that an increase in the cost of funds for banks also increases the opportunity cost of using money, and that the demand for credit card loans is more sensitive to this opportunity cost.

does not show a substantial upward or downward movement during a non-monetary downturn. These two striking findings regarding the behavior of bank equity suggest that the recorded value of current-period profits could play an important role during the monetary transmission mechanism.

4 Interpretation of the results

Understanding what happens during the monetary transmission mechanism is a difficult question. But we think that some important lessons can be learned from the results presented here, in particular, the results shed light on whether there is a reduction in the supply of bank loans. The results are consistent with the hypothesis that the supply of consumer and real estate loans decreases during a monetary tightening. To reconcile the observed increase of C&I loans with a credit crunch, however, is more difficult. Bernanke and Gertler (1995) argue that the observed increase can still be consistent with a reduction in supply if the observed build up of inventories leads to an increase in the demand for C&I loans. This explanation, however, raises the following questions. First, since rates on C&I loans do not increase by much more than the federal funds rate one would need that both the demand and the supply of C&I loans are elastic. Second, if the increase in C&I loans is due to an increased demand (triggered by a build up of inventories) then why is the increase so persistent, whereas the increase in inventories is only temporary?[19] Third, if an increase in inventories leads to an increase in C&I loans during a monetary downturn, then why doesn't an increase in inventories lead to a similar increase in C&I loans after a non-monetary shock? Fourth, if firms increase their demand for C&I loans during a (temporary) monetary downturn, and reduce their demand in response to a (more persistent) output shock, then why do consumers not increase their demand for bank loans during a monetary downturn?

Another possibility is that firms borrow more to finance the increase in interest payments. This explanation would fit the timing of the response better. A drawback of this explanation is that one would only expect the demand for C&I loans to *increase* for firms that are financially constrained. But Gertler and Gilchrist (1993a) actually show that bank lending to small firms declines during a monetary tightening, while it increases to large firms, and typically it is thought that large firms are less likely to be constrained.

This raises the question as to whether one should seriously consider the possibility that the supply of C&I loans actually increases during a monetary tightening, a

[19] Bernanke and Gertler (1995) document that the increase in inventories is temporary and we find the same for our data set.

view that is reinforced when one compares the positive response of C&I loans during a monetary downturn with the strong negative response during a non-monetary downturn. Below we give four reasons why banks may want to change the composition of their loan portfolio during a monetary tightening. If the substitution effects are strong enough the supply of C&I loans could actually increase.

The first reason is related to differences in risk, the second to differences in the market structure, the third reason refers to hedging, and the fourth is related to bank capital regulation and the effect that the short-term interest rate has on the current-period profit margins of the different loan components.

Reason I: Stronger balance-sheet channel for consumers In the recent literature the balance-sheet channel has received a lot of attention. This channel, like the bank-lending channel, stresses credit market frictions but instead of focusing on the balance sheet of the bank this channel focuses on the balance sheet of the borrower. The idea is that healthy balance sheets lessen the impact of frictions, such as information asymmetries and limited enforcement, and make it possible for the borrower to receive more funds from the lender. Suppose that the "balance-sheet effect" is quantitatively more important for consumers than for firms. Banks respond by reducing the supply of loans to consumers (both real estate and consumer), which would make it easier for banks to supply funds to firms. Since we look at the responses for a monetary downturn relative to the responses for a non-monetary downturn, the "balance-sheet effect" does not refer to a worsening of the balance sheet because of a change in real activity, but only because of an increase in interest rates. Why would an increase in interest rates be more harmful for consumers, and, thus, have a bigger effect on consumer loans and real estate loans?[20] One possibility is that interest payments are a larger fraction of expenditures for consumers than for firms. Another possibility is that the increase in interest rates leads to a decrease in property prices[21], which is more harmful for the credit worthiness of consumers than firms.[22]

Reason II: Stickiness of rates on consumer loans In section 3.2 we pointed out that there is some evidence that rates on consumer loans and especially credit-

[20] Our real estate loan series also includes mortgages to firms and in none of our data sets can we separately identify residential mortgages.

[21] See McCarthy and Peach (2002).

[22] The data on delinquency and charge-off rates for the three loan components only start in 1986 and is unfortunately not long enough to estimate impulse response functions. A visual inspection of the data do not provide evidence that one of the three components becomes particularly more risky following a monetary tightening.

card loans are not very flexible. This means that during periods of a monetary tightening the spread on consumer loans decreases.[23] This reduction in the spread is likely to be accompanied by a reduction in the supply of consumer loans, which would make it possible for banks to increase C&I loans.

Reason III: Changes in interest rates and hedging Financial institutions tend to mismatch their balance sheet maturities to some degree.[24] This makes them vulnerable to changes in interest rates. Through hedging they try to limit this risk. What is important for our paper is that hedging affects the banks' loan portfolio as well as the yields earned on the various loans. Perli and Sack (2003) point out that *"It is indeed a common view among fixed-income market participants that mortgage hedging activity has frequently amplified movements in long-term interest rates".* Although there are several ways in which banks try to hedge against unforeseen changes in interest rates one important way to hedge is by adjusting the portfolio in order to align the maturities of assets and liabilities. When interest rates increase, the expected maturity of mortgage loans increase because lenders are less likely to refinance. To compensate for the increase in the maturity of their assets banks will sell long-term assets, which increases long-term rates. So this type of hedging behavior cannot only explain a substitution out of mortgage loans, but can also explain why long-term rates increase by much more than is predicted by the expectations hypothesis. The tightening of monetary policy in 1994 is a good example to illustrate this effect. From February through May of 1994 the federal funds rate increased by 125 basis points. Interestingly, long rates began to rise in October 1993, several months before the tightening actually took place. Moreover, during the same period of time the 125 basis point increase in the federal funds rate was accompanied by a 133 basis point increase in the ten-year Treasury rate. One argument that hedging was important for this movement in long rates is that the yield curve did flatten for maturities over ten years and that the maximum maturity of the bonds used for hedging is ten years.[25]

Reason IV: Current-period profitability and the Basel Accord The effect of changes in interest rates on banks' profitability has received a lot of attention in the literature.[26] The literature shows that the effect is ambiguous and depends on how profitability is measured. The discussion below will make clear why the effects are ambiguous, but the focus in this section is more limited. We are mainly

[23] More thorough empirical evidence can be found in Calem and Mester (1995).
[24] See, for example, Saunders (1994, p. 84).
[25] See Fernald, Keane, and Mosser (1994).
[26] For references see Hasan and Sarkar (2002).

interested in the consequences of changes in the interest rate on *recorded* current-period earnings. Recorded current-period earnings are important because they affect the book value of bank equity[27] and, thus—because of bank capital regulation—the amount of risky assets a bank can have on its balance sheet. The Basel Committee on Banking Supervision is aware that banks can be "*vulnerable to fluctuations in recorded profits, irrespective of whether any losses incurred may be offset, under the economic approach, by larger earnings which, because of accounting conventions, will only emerge gradually over the years.*"[28] Also, Berger, Herring, and Szegö (1995) point out that calculating the market value of bank equity is not only really difficult, but is also not appropriate for regulatory purposes since it contains the value of the bank's limited liability, and the regulator bears most of the cost of this option.

In particular, with the adoption of the 1988 Basel Capital Accord in the United States under the 1991 Federal Deposit Insurance Corporation Improvement Act (FDICIA) regulation banks are required to hold minimum bank equity levels, which are stated as a percentage of risk-weighted assets. But even before the adoption of the Basel Capital Accord, commercial banks had reasons to be concerned about their bank equity position. The first nationwide capital requirement for commercial banks was mandated by the International Banking Act of 1978. Prior to 1978 the only federal capital standards were for newly chartered banks and other capital standards were ad hoc, usually implemented as an incident to a Bank Holding Company application.[29,30]

Several empirical studies find that there is a robust link between bank profitability and loan growth.[31] As discussed by Sharpe (1995), it is typically difficult, if not impossible, to determine whether a reduction in bank capital leads to a reduction in lending because of regulation, or whether low bank profitability is correlated with other variables important for the amount of bank loans issued.[32]

Because banks finance long-term assets with short-term liabilities and rates on long-term assets change by less than short-term interest rates one can expect current-period earnings on long-term assets to be negatively affected by an increase in short-

[27] In BIS (2004) it is pointed out that traditional sources of non-interest income, such as transaction processing fees, are becoming more interest rate sensitive.

[28] See BIS (1993, page 10).

[29] See Greenbaum and Thakor (1994).

[30] Banks are likely to care about bank equity even without capital regulations. For example, Meh and Moran (2004) develop a model without bank capital requirements in which banks still hold equity in equilibrium to alleviate agency problems.

[31] See Sharpe (1995) for an overview.

[32] That the market value of bank equity is important is shown in Peek and Rosengren (1997). They show that bank lending of Japanese banks in the United States was negatively affected in the early nineties when reductions in Japanese stock prices reduced the market value of bank equity.

term interest rates leading to a reduction in bank equity. In Figure 6 we showed that these effects are quantitiatvely important. Suppose a bank is concerned about the book value of its equity and, thus, about its recorded profits. Then this bank would dislike assets with low current-period profit margins. Those are long-term assets, such as real estate loans, or assets where the market structure makes interest rates less flexible, such as consumer loans.

The particular amount of equity that banks must hold for different asset categories is likely to matter too. Long-term assets have more market risk and require more bank equity for this reason. Moreover, increases in the interest rate increase the duration of mortgages and thus the amount of market risk. On the other hand, mortgages are collateralized and, therefore, require less capital.[33] Treasury bonds do not require any bank capital at all.

5 Concluding Comments

This paper is empirical in nature documenting some important characteristics of banks' loan portfolio following a monetary tightening. A very striking observation is that large changes in the portfolio are observed: banks substitute out of real estate and consumer loans and into C&I loans. Following a non-monetary shock that also leads to a reduction in real activity (but not to an increase in interest rates), there are also changes in the composition of banks' loan portfolios. However, in this case there is a relative substitution out of C&I loans. Developing a model that is consistent with these findings is an important challenge for future research. We think that such a theory should not only be consistent with the observed responses to monetary and non-monetary shocks but also be consistent with the behavior of interest rates. In particular, interest rate responses should display a substantial increase in the term premium and no noticeable increase in the premium on C&I loans. We found only the rate on personal consumer loans to be insensitive to changes in the federal funds rate in the short term, but several papers in the literature have pointed out that credit-card rates are sticky as well.

It seems to us that our empirical findings are difficult to explain using arguments based on an increased demand in C&I loans to finance inventories. We argue that one should take seriously the possibility that portfolio considerations imply that the supply of C&I loans actually increase following a monetary tightening. This finding

[33] Den Haan, Sumner, and Yamashiro (2004) develop a simple portfolio model in which capital-adequacy risk weights affect the portfolio composition in the steady state, but an increase in the short-term interest rate leads to a substitution out of long-term into short-term loans independent of what the risk weights are.

still leaves open the possibility that the supply of total bank loans decreases following a monetary tightening. It is nevertheless quite a revolutionary thought though, since the literature typically focuses on the role of bank lending to firms.[34] Studies that focus on a reduction in bank loans to consumers may be more relevant and in particular may make progress in explaining the important empirical finding reported in Bernanke and Gertler (1995) that the most rapid and (in percentage terms, by far the strongest) effect of a monetary policy shock is on residential investment whereas business structure investment, also a long-lived investment, does not seem to be much affected. Also, the recent reduction in the federal funds rate mainly seemed to have stimulated consumption spending and residential investment, and not business investment.

A Appendix

In this section we give the data sources and provide more detailed information about the variables used. The names we use for the data sets are related to the source for the loan variables but note that each data set also includes other variables.

A.1 Quarterly Call data set

Our first data set is based on the Call reports and starts in the first quarter of 1977 and ends in the second quarter of 2004. The data set is available at http://www.csulb.edu/~gyamashi/CallReportData.html. A description of how they are constructed can be found in Den Haan, Sumner, and Yamashiro (2002).[35] In this paper we use an index series that corrects for mergers. The universe of commercial banks for the Call Reports is almost identical to the one used to construct the H8

[34] See, for example, Fisher (1999), Gertler and Gilchrist (1993a,1994), Kashyap and Stein (1995), Kashyap, Stein, and Wilcox (1993), Repullo and Suarez (2000), and Warner and Georges (2001). In contrast, Ludvigson (1998) considers consumer loans and finds that automobile loans issued by banks decrease more during a monetary downturn than other automobile loans.

[35] In the Call Reports banks report on a "consolidated foreign and domestic" basis (RCFD) or on a "domestic only" basis (RCON). In general, the largest banks only provide data on a consolidated foreign and domestic basis so for several variables one would have to use the RCFD data. This is not true for all variables, however, and in particular it is not true for bank loans. We choose to use the RCON data for the following reasons. First, the RCON data are more appropriate for a study that looks at the relationship between bank loans and *domestic* real activity. Second, the RCON series are more comparable to the H8 data since the H8 data also do not include assets and liabilities outside the United States. Third, the RCFD data display a break in December 1978.

series for domestically-chartered banks.[36] Savings and loan banks are not included in any of the data sets. The Call Reports allow us to include savings and loan banks but in the beginning of the sample they report infrequently. See Den Haan, Sumner, and Yamashiro (2002) for a further discussion.

Quarterly observations for the CPI and federal funds rate are constructed by taking an average of the monthly observations. The CPI is the seasonally adjusted series downloaded from http://research.stlouisfed.org. The federal funds rate is from the historical data set of the Federal Reserve System (H.15). The income variable used is personal income (by place of work) from the Bureau of Economic Analysis. It was downloaded from http://www.bea.doc.gov/. In related work we examine the effect of monetary policy shocks on regional lending, and the advantage of this real activity measure is that it is available at the regional level. The results are very similar, however, if we use GDP and its deflator, which we document for some key results in Den Haan, Sumner, and Yamashiro (2005).

A.2 Monthly H8 data set

The second data set uses (seasonally adjusted) bank loan variables provided by the Federal Reserve System in the "Assets and Liabilities of Commercial Banks" data set (H.8). The data start in January 1960 and end in February 2003. We use the bank universe that includes all commercial banks.[37] The measure for real activity is the seasonally adjusted series for Industrial Production from the Federal Reserve System (G.17). The price index used is the seasonally adjusted CPI.

A.3 Additional data

The rate on C&I loans is the weighted-average effective loan rate on all C&I Loans made by domestic commercial banks. The source is the quarterly Survey of Terms

[36] The difference is that the H8 universe also includes non-deposit trust companies (rssd9048=250). We did not include them because these institutions report irregularly in the beginning of the Call report sample and the size of their loan portfolio is very small relative to the total loan portfolio of commercial banks.

[37] The universe of domestically-chartered commercial banks in the H8 is virtually identical to the set of commercial banks in the Call reports. The H8 series for domestically-chartered banks only starts in 1973, however, so we use the H8 series for all commercial and industrial banks. Besides domestically-chartered banks the H8 series for all commercial banks includes: branches and agencies of foreign banks, state-licensed agencies acting as a bank, Edge-Act corporations, New York investment companies, and the American Express International Banking Corporation. This information was provided to us by William Watkins of the Board of Governors of the Federal Reserve System. See Den Haan, Sumner, and Yamashiro (2002) for details.

of Business Lending provided by the Federal Reserve System (E.2). The rate on 24-month personal loans are based on loans issued by commercial banks. The source is the quarterly Consumer Credit data set of the Federal Reserve System (G.19). The mortgage rate is the contract rate on 30-year, fixed-rate conventional home mortgages. The long-term treasury rate is the constant-maturity 10-year rate. The last two series are from the historical data set of the Federal Reserve System (H.15) and quarterly series are obtained by taking the average of monthly observations.

The bank equity data used are based on the Call Reports and described in Den Haan, Sumner, Yamashiro (2002). It consists of the sum of common equity and its surplus, undivided profits, and capital reserves less the net unrealized loss on marketable equity securities.[38] Inventories are real private inventories (non-farm, seasonally adjusted) from the National Income and Product Accounts (NIPA table 5.7.6).

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[38] There are two reasons to include loan reserves. First, without it there is a dramatic drop in bank equity in the second quarter of 1987 when banks responded to Brazil's announcement that it would cease paying its debts by allocating large amounts to their loan reserves. Second, loan loss reserves are included in the measure of Tier 2 regulatory capital, which is used in calculating a bank's required capital adequacy ratio.

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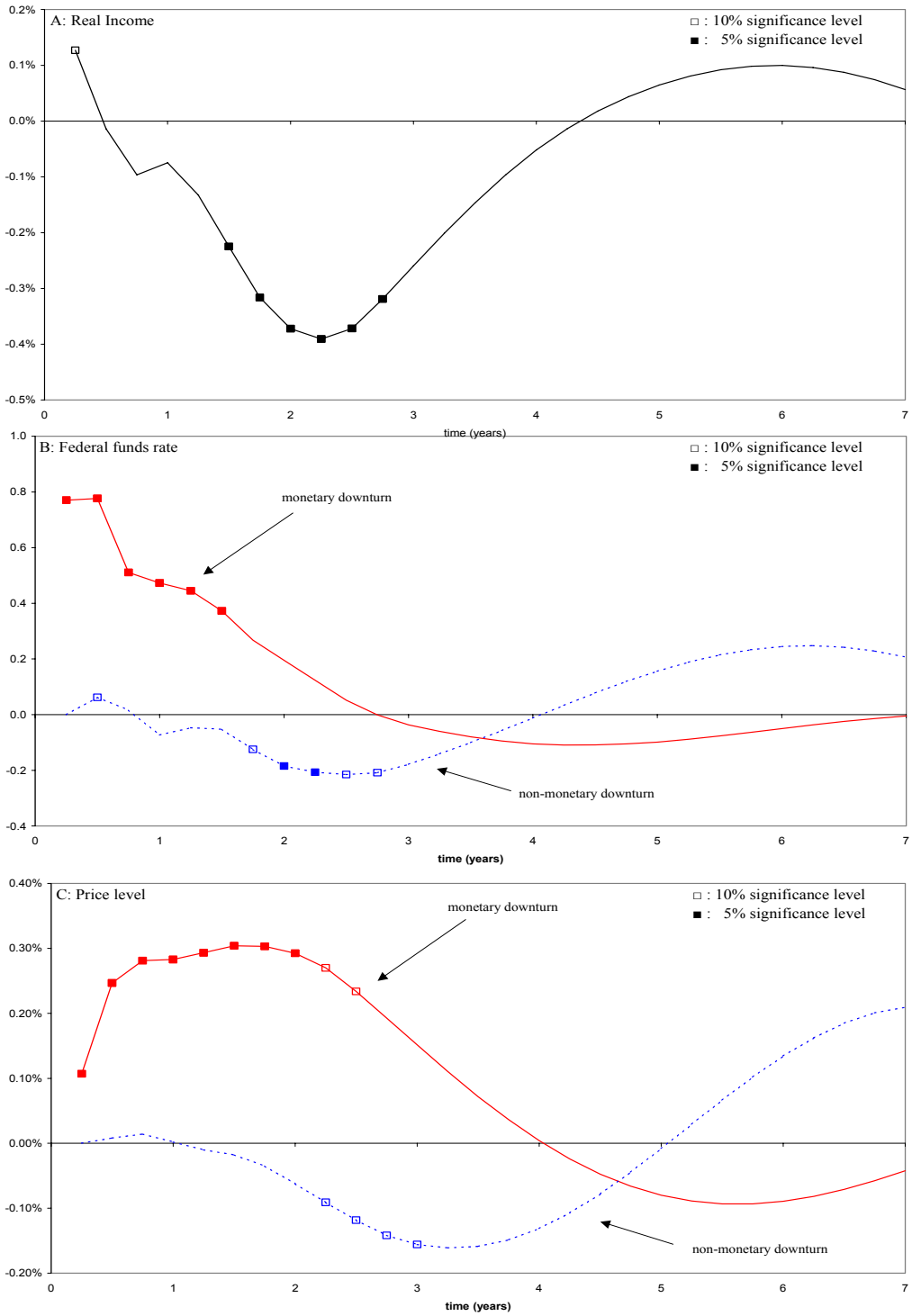
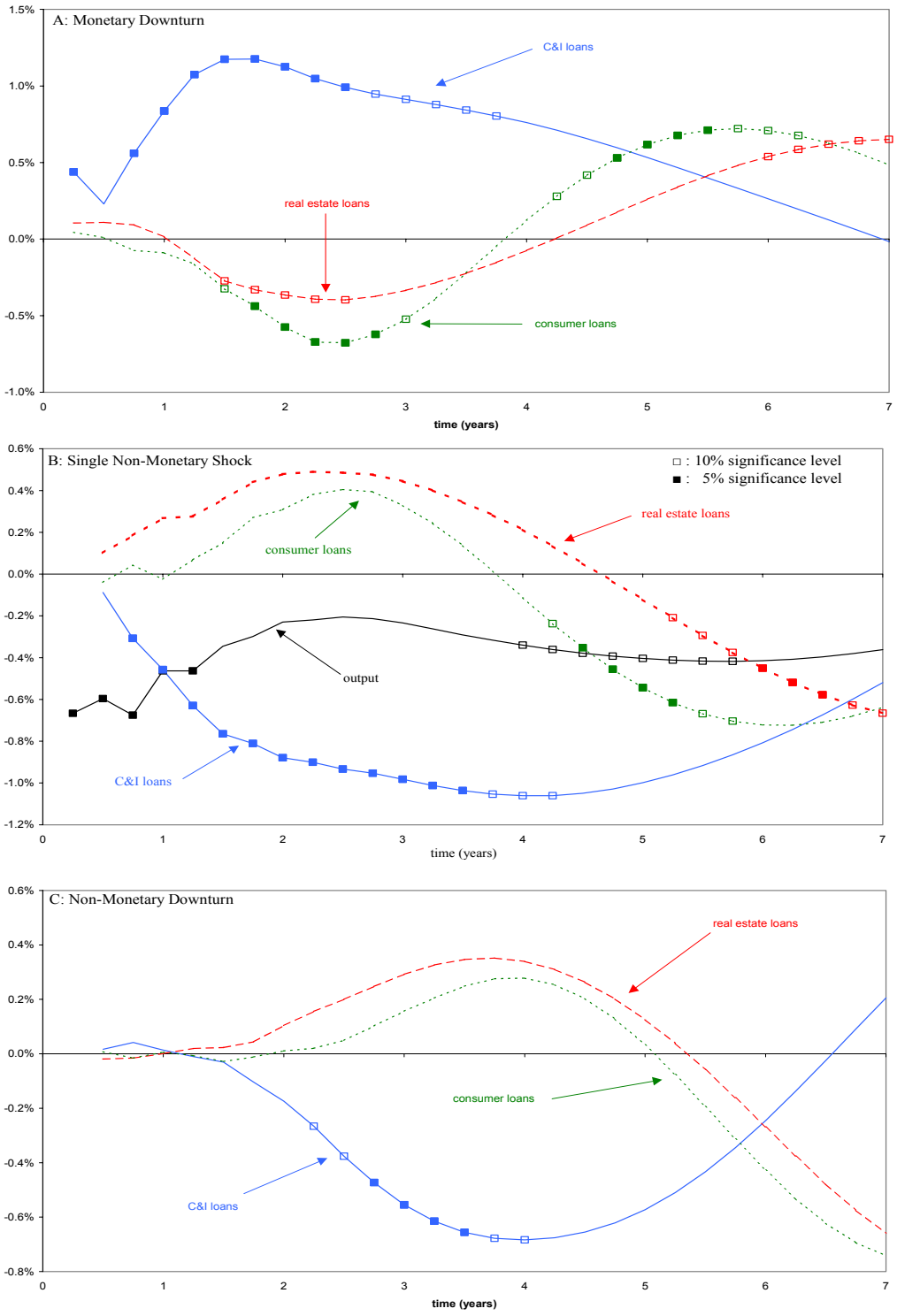
Figure 1: Responses of real income, the interest rate, and the price level



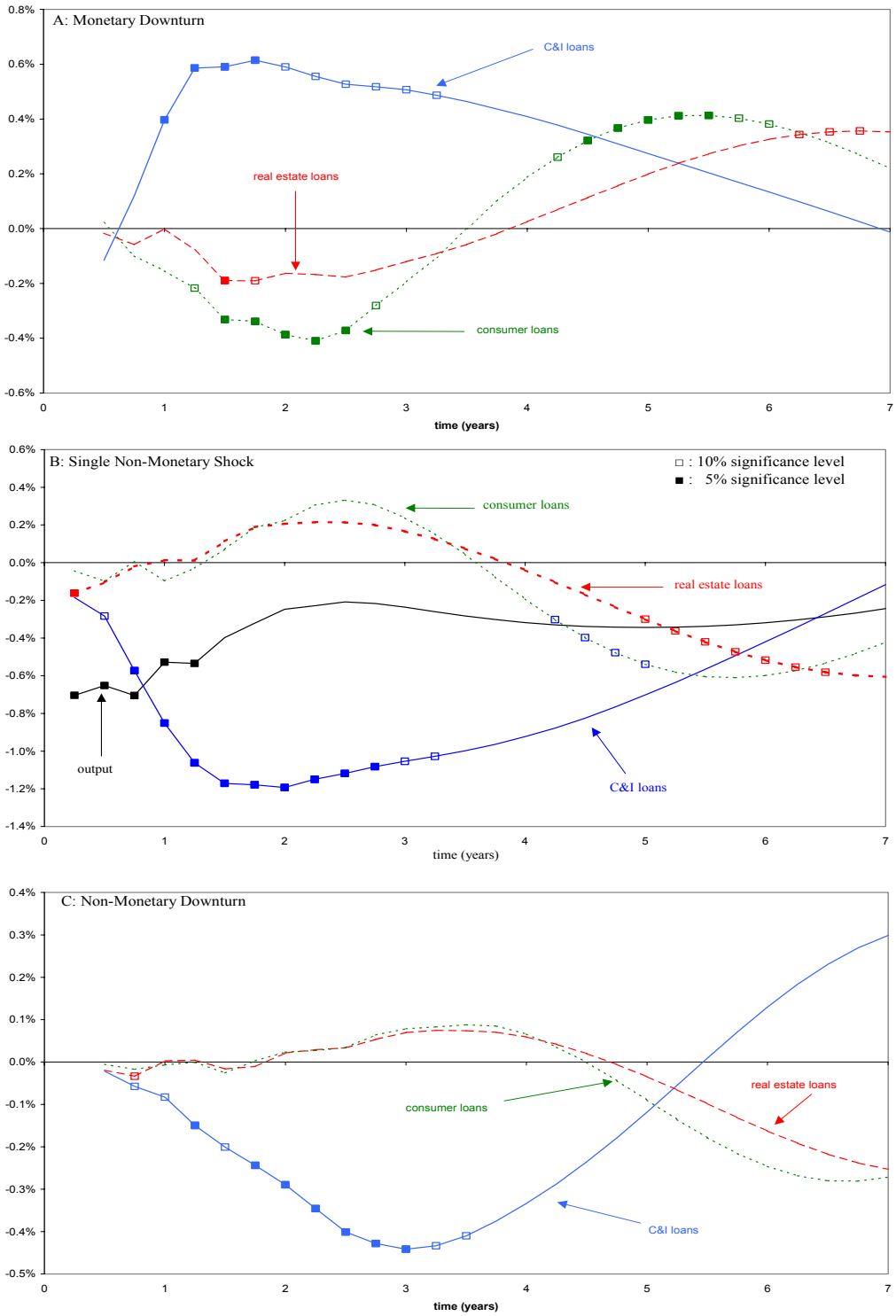
Note: These graphs plot the response of the indicated variable to a one-standard deviation shock to the federal funds rate, i.e., a monetary downturn. In Panels B and C the curve labelled "non-monetary downturn" plots the time path of the indicated variable following a sequence of non-monetary shocks that generates a time path for output that is identical to that of the monetary downturn plotted in panel A. The results are based on the benchmark identification specification. Open squares indicate a significant response at the 10% level and solid squares indicate a significant response at the 5% level (both one-sided tests).

Figure 2: Responses of the loan components



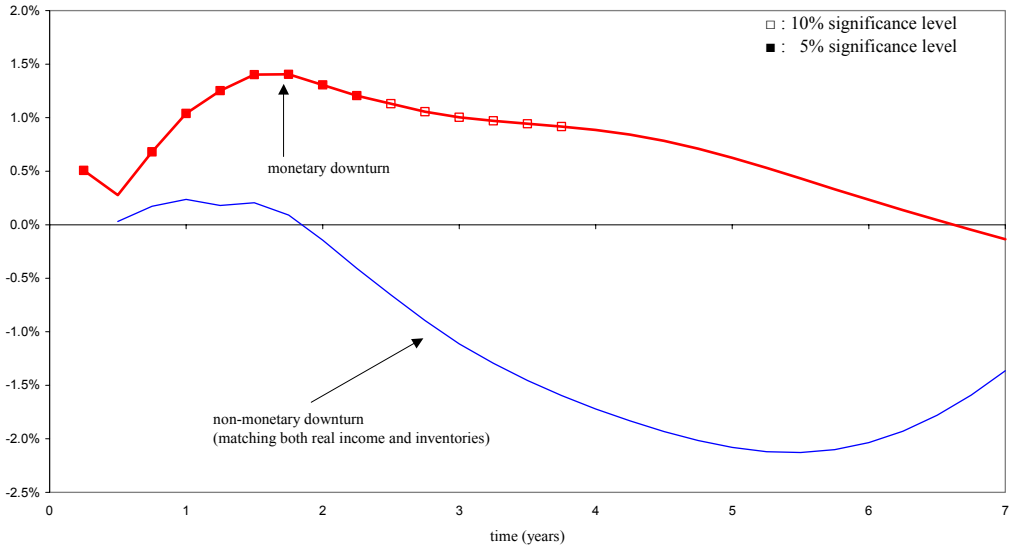
Note: Panel A plots the response of the loan components to a one-standard deviation shock to the federal funds rate, i.e., a monetary downturn. Panel B plots the response of output to a one-standard deviation non-monetary or output shock and the corresponding responses of the loan components. Panel C plots the response of the indicated loan variable following a sequence of non-monetary shocks that generates a time path for real income that is identical to that of the monetary downturn plotted in panel A of Figure 1. The results are based on the benchmark identification specification. Open squares indicate a significant response at the 10% level and solid squares indicate a significant response at the 5% level (both one-sided tests).

Figure 3: Responses of the loan components (alternative identification)



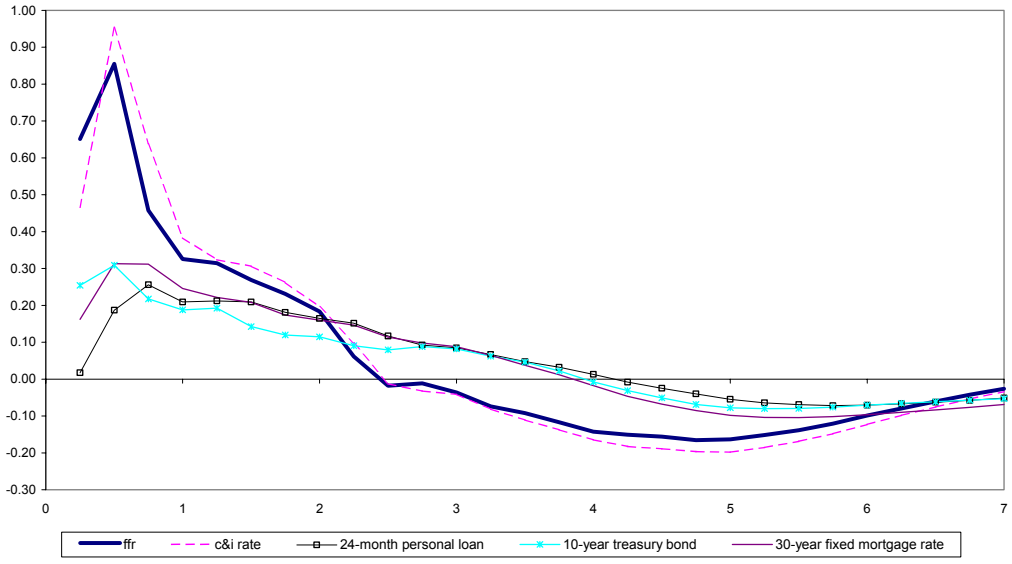
Note: Panel A plots the response of the loan components to a one-standard deviation shock to the federal funds rate, i.e., a monetary downturn. Panel B plots the response of output to a one-standard deviation non-monetary or output shock and the corresponding responses of the loan components. Panel C plots the response of the indicated loan variable following a sequence of non-monetary shocks that generates a time path for real income that is identical to that of the monetary downturn plotted in panel A of Figure 1. The results are based on the VAR specification with all variables included in X_{1t}. Open squares indicate a significant response at the 10% level and solid squares indicate a significant response at the 5% level (both one-sided tests).

Figure 4: C&I loans (Controlling for inventories in non-monetary downturn)



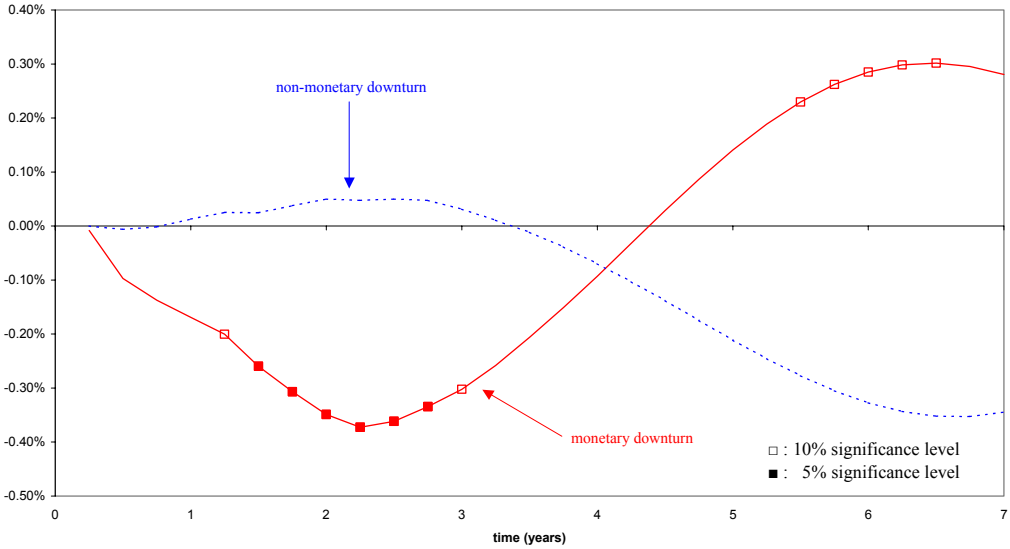
Note: This graph plots the response of C&I loans to a one-standard deviation shock to the federal funds rate, i.e., a monetary downturn. The curve labelled "non-monetary downturn" plots the time path of C&I loans following a sequence of output *and* inventory shocks that generates a time path for real income and inventories that is identical to that of the monetary downturn. The results are based on the benchmark identification assumption. Open squares indicate a significant response at the 10% level and solid squares indicate a significant response at the 5% level (both one-sided tests).

Figure 5: Responses of interest rates to a monetary policy shock



Note: This graph plots the response of the indicated interest rate to a one-standard deviation innovation to the federal funds rate. The variables included in the VAR are the five interest rates and real income. The benchmark identification assumption is used.

Figure 6: Bank equity



Note: This graph plots the response of bank equity to a one-standard deviation shock to the federal funds rate, i.e., a monetary downturn. The curve labelled "non-monetary downturn" plots the time path of bank equity following a sequence of non-monetary shocks that generates a time path for real income that is identical to that of the monetary downturn. The results are based on the benchmark identification specification. Open squares indicate a significant response at the 10% level and solid squares indicate a significant response at the 5% level (both one-sided tests).