# Behavior and Importance of Bank Loan Components after Monetary and Non-Monetary Shocks

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**Abstract:** In this paper we analyze the behavior of loan components during economic downturns that are caused by a monetary tightening and compare it to the behavior during similar non-monetary downturns. Consistent with the lending view, we find that total loans decrease more during monetary downturns than during non-monetary downturns. We find that the opposite holds for commercial and industrial loans and that the effect is stronger for small banks. The bank lending view typically doesn't consider loan components and interprets the decline in total loans as a reduction in business loans that is believed to worsen the recession. Using a simple theoretical framework, we show that the observed substitution out of (long-term) real estate loans and into (short-term) commercial and industrial loans during periods of high interest rates occurs in the presence of exactly the kind of frictions that are used in the literature to explain the decline in total loans such as the inability of banks to attract time deposits to replace checkable deposits. Using state level data we show that those regions where the substitution into commercial and industrial loans is the larger are also the regions where the decrease in real income is the smaller. Commercial and industrial bank loans, thus, seem to dampen the effects of high interest rates.

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## 1. Introduction

Monetary policy is thought to be an important tool with which the government can influence real activity. How monetary policy affects the economy has been subject to much debate, and several competing theories exist. In the absence of credible fully specified structural models, empirical work has focused mainly on the effects of monetary policy innovations using structural vector-autoregressive models or VAR's. Unfortunately, it is difficult to use empirical studies to distinguish between competing theories. The reason is that although the competing theories express different views on what causes what, they have similar implications about the general comovement of important variables like money and loans. Moreover, because changes in variables are affected by agents' expectations, the timing of variable movements is also not conclusive.

In this paper we estimate aggregate and regional responses to a monetary contraction for income and three lending components, commercial and industrial loans, real estate loans and consumer loans. The goal is to use the variation observed across regional responses and across loan components to provide important additional insights in the monetary transmission mechanism. Unfortunately, interpretation of the responses of loan variables is hampered by the fact that during an economic downturn the demand for loans changes. Moreover, it is difficult to predict the direction in which demand will push loans. Even an increase in loans can, thus, be consistent with a reduction in supply if demand increased by an even greater amount. To deal with this dilemma, we assess which part of the loan responses is caused by changes in income, by comparing the behavior of bank loans during a monetary downturn, that is,

an economic slowdown caused by a monetary contraction, with a non-monetary downturn, that is, a similar economic slowdown caused by real shocks. By construction, real activity decreases by the same amount during monetary and non-monetary downturns and the main difference between a monetary and a non-monetary downturn is that interest rates are higher during a monetary downturn. Consistent with the bank lending view,[1] we find that total loans decrease more during a monetary downturn than during a non-monetary downturn. For commercial and industrial loans, however, we find that loans are relatively stable during a monetary downturn but decrease sharply during a non-monetary downturn. Our results suggest that at fixed income levels an increase in interest rates generate a strong substitution out of real estate loans into commercial and industrial loans.

This relative increase in commercial and industrial loans during monetary downturns stands in stark contrast with the bank lending view. We develop a theoretical model to explain the substitution out of real estate loans into commercial and industrial loans during periods of high interest rates. The friction that banks have difficulty replacing checkable deposits with time deposits during a monetary contraction plays a key role in our model. It is exactly this kind of friction that is used in the literature to motivate the bank lending channel is. Note that one would suspect this friction to be more important for small banks. Indeed we find that the substitution into commercial and industrial loans is more important for small banks.[2] Our paper is, thus, in spirit very similar to those that support a bank lending channel, but we show

[1] See Bernanke and Gertler (1995), Kashyap, Stein and Wilcox (1993) or Kashyap and Stein (1995) for a description of the bank lending view.
[2] As in Kashyap and Stein (1995) we find that the decrease in total loans is bigger for small banks.

that the fact that loan components differ in their maturities and other characteristics cause them to move in different directions during a monetary contraction in environments that also give rise to a lending channel.

This paper is also similar in spirit to those that support a bank lending channel by showing that bank loans have a positive effect on real activity. In particular, we use the differential responses across regions (either the nine census regions or the states) to show that the atypically low amount of real estate loans during a monetary downturn worsens the recession and the atypically high amount of commercial and industrial loans dampens the recession.

We are not the first study to use disaggregated empirical data to study the monetary transmission mechanism. For example, Gertler and Gilchrist (1994) disaggregate by firm size and show that sales of small firms decrease more than the sales of large firms after a monetary tightening. Kashyap and Stein (1995) disaggregate by bank size and show that small banks reduce their amount of outstanding loans by more than large banks after a monetary tightening. Although attractive from a theoretical viewpoint, these disaggregation criteria have the disadvantage that they do not use matching measures for real and financial activity. For example, since Kashyap and Stein (1995) do not have data on the output of the clients of small banks they cannot establish that the differential response between small and large banks is important for real activity. The advantage of disaggregating by region is that one can match regional financial measures like bank loans with regional real activity measures. Several studies, most notably Peterson and Rajan (1995), have documented that this link is quite strong for commercial and

industrial loans. This is because commercial and industrial loans are not standardized products and the relationship between firms and banks is clearly an important element in the market for business loans.

This paper is organized as follows. In Section 2 we use aggregate data to compare the behavior of loan components during monetary and non-monetary downturns. In Section 3 we develop a theoretical framework for the observed responses in the loan components. In Section 4 we study the differential responses in the loan components in different regions and we discuss the importance of loans for real activity during the monetary transmission mechanism. In Section 5 we evaluate different interpretations for our results and the last section contains concluding comments.

## 2. The Effect of Monetary Policy Shocks on Loan Components

In this section we analyze the behavior of aggregate loan components during monetary downturns, that is, downturns caused by a monetary tightening, and compare it with the behavior during similar downturns that are not caused by a monetary tightening. Although income behavior is the same in both types of recessions, interest rates are high during monetary downturns and low during non-monetary recessions.

In Section 2.1 we provide some descriptive statistics to characterize the time series behavior of loan components and their comovements with real income and interest rates. In Section 2.2 we discuss the empirical framework that allows us to identify the loan behavior during monetary and non-monetary downturns. The results are discussed in Section 2.3.

### 2.1. Descriptive statistics of the data

The main purpose of this section is to document that the time series behavior of commercial and industrial bank loans is substantially different from that of both real estate and consumer bank loans. In Figure 1 we plot the HP-filtered residuals of aggregate personal income,[3] commercial and industrial loans, real estate loans and consumer loans. The graphs document that aggregate real estate and consumer loans typically move with aggregate income. The correlation coefficients between aggregate income and real estate loans and between aggregate income and consumer loans are equal to 0.66 and 0.72, respectively. Commercial and industrial loans on the other hand are less procyclical and the correlation coefficient is only equal to 0.26. To shed some light on the dynamic properties of the correlation patterns, we also calculate the correlation coefficients of the forecast errors for aggregate income and the loan components at different forecast horizons.[4] Figure 2 plots the results. We observe that particularly at the longer forecast horizons commercial and industrial loans display less comovement with income than the other two loan components. In the short run, movements in real estate and consumer loans are also less strongly correlated with movements in income and are only slightly larger than the comovements observed for commercial and industrial loans. Figure 3 plots the dynamic correlation coefficients of the three loan components with the federal funds

[3] Since state output is not available at a quarterly frequency we use earnings by place of work. See the Appendix A for further information on the data sources. All real series are deflated with the consumer price index (CPI).

rate. We see that commercial and industrial loans are more strongly correlated with the federal funds rate than the other two loan components. Only for consumer loans do we observe negative correlation coefficients.

### 2.2 Identifying assumptions

The standard strategy to study the impact of monetary policy on economic variables is to estimate a structural VAR using a limited set of aggregate variables.[5] Consider the following VAR:[6]

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

where $Z_t^{'} = \left[X_{1t}^{'}, f_t, X_{2t}^{'}\right]$, $X_{1t}$ is a ($k_1 \times 1$) vector with elements whose contemporaneous values are in the information set of the central bank, $f_t$ 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. To proceed one has to assume that there is a relationship between the residual terms, $u_t$, and the fundamental shocks to the economy, $\varepsilon_t$. We assume this relationship is given by:

(2.2) $u_t = \overline{A}\varepsilon_t$,

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[4] This procedure is proposed in Den Haan (2000) and the software is available at http://weber.ucsd.edu/~wdenhaan. The forecast errors are from a bivariate VAR when AIC is used to determine lag lengths and the choice of deterministic trend terms.
[5] See Christiano, Eichenbaum and Evans (1999) for an excellent overview.
[6] To simplify the expression we do not display constants and seasonal dummies that are also included.

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

(2.3) $\quad \mathrm{E}[u_t u_t^{'}] = \overline{A}\,\overline{A}'$.

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, additional restrictions are needed to estimate $\overline{A}$. We assume that $\overline{A}$ has the following *block*-triangular structure:

(2.4) $$\overline{A} = \begin{bmatrix} \overline{A}_{11} & 0 & 0 \\ \overline{A}_{21} & \overline{A}_{22} & 0 \\ \overline{A}_{31} & \overline{A}_{32} & \overline{A}_{33} \end{bmatrix},$$

where $\overline{A}_{11}$ is a ($k_1 \times k_1$) matrix, $\overline{A}_{21}$ is a ($1 \times k_1$) matrix, $\overline{A}_{22}$ is a ($1 \times 1$) matrix, $\overline{A}_{31}$ is a ($k_2 \times k_1$) matrix, $\overline{A}_{32}$ is a ($k_2 \times 1$) matrix and $\overline{A}_{33}$ is a ($k_2 \times k_2$) matrix. Note that the information assumption made above implies that $\overline{A}_{23} = 0$. Assuming that $\overline{A}$ is lower triangular (and the diagonal elements are positive) would exactly impose the necessary number of restrictions to uniquely determine the elements of $\overline{A}$, but the *block*-triangular structure imposed in (2.4) makes fewer restrictions. Nevertheless, Christiano, Eichenbaum and Evans (1999) show that the block-triangular structure is enough to identify the effects of the monetary policy shock. This means that the ordering of the variables within $X_{1t}$ and $X_{2t}$ is irrelevant for the impulse responses to the monetary policy shock. The only assumption needed to identify impulse response functions of monetary policy shocks is the allocation of variables to $X_{1t}$ and $X_{2t}$.

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. Throughout this paper we assume 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. We refer to this assumption as the "Limited Contemporaneous Information" or LCI assumption in contrast with the "Full Contemporaneous Information" or FCI assumption for which $X_{2t}$ is empty. Under the FCI assumption the monetary authority can respond to current-period innovations in the other variables, but other variables can only respond to monetary policy innovations with a lag. While we do believe that over a period of a quarter the FED responds to current information, the data available to economic researchers is in most cases final, revised data. Rudebusch (1998) points out that the estimated coefficients of the VAR will be subject to bias and inconsistency if the FED responds to the innovations of contemporaneous values of original data but the econometrician assumes that the FED responds to innovations in the contemporaneous values of the revised data. Therefore, since the revised data set was not available to the monetary authority at the time of their actions we feel that the LCI assumption is reasonable and is to be preferred to the FCI assumption.[7]

In response to a monetary policy shock, the included variables like bank loans can respond directly to the change in the federal funds rate, but they can also react in response to changes in variables like real income. Especially in the case of bank loans, it always has been an unresolved question how one can determine which part of the

[7] Yamashiro (2001) estimates an empirical VAR under both the LCI and the FCI assumption in a similar context and finds that the results are qualitatively very similar. Croushore and Evans (2000) show that results using real-time data are similar to those using revised data.

response is a direct response to the monetary tightening and which part is an endogenous response to the subsequent economic downturn. In this paper we propose to answer this question by comparing the behavior of bank loans after a negative monetary policy shock to the behavior of bank loans after a series of income shocks. The magnitudes of the income shocks are chosen such that the resulting time path of real income is exactly identical to that observed during a monetary tightening.

Expectations about future income movements are not identical during both types of recessions, since a monetary downturn is caused by a one-time shock and a non-monetary downturn by a sequence of shocks. In Section 4, where we discuss the results with regional data, and at the end of this section, we show that the same conclusion is reached when we compare the monetary downturn with a similar non-monetary downturn caused by a one-time real shock.

### 2.3. Loan components' behavior in monetary and non-monetary downturns

In this section we present the responses of the variables to a monetary tightening and compare the behavior of loans during a downturn caused by monetary tightening with a non-monetary downturn during which interest rates decrease. We will refer to the difference between the two responses as the income-corrected response. We will start with a description of the estimate VARs.

*Sample period and VAR specifications*

In the VAR we include besides the federal funds rate, the rate on 30 year mortgages, the rate on commercial and industrial loans, the consumer price level,

deflated aggregate commercial and industrial bank loans, deflated aggregate real estate loans, deflated aggregate consumer loans, and deflated aggregate income. We consider two different VAR specifications. In the first specification, the set of explanatory variables in each regression equation is determined by the Akaiki Information Criterion (AIC).[8,9] The maximum lag length considered is four. We will refer to this specification as the fixed-four-lag specification. When the lag length is constrained to be the same in each equation and for each dependent variable, then AIC chooses four lags and the Schwartz or Baysian Information Criterion (BIC) chooses two lags. Since the specification with four lags is in many respects similar to the first specification, we use as the second specification the one where each equation contains two lags of each dependent variable. We will refer to this specification as the fixed-two-lag specification. Although the results are fairly similar for the two specifications, there are some findings that differ in magnitude or timing.

The VAR's are estimated over the sample period from the first quarter of 1977 to the second quarter of 2000. Data sources and the construction of the bank loan variables are described in Appendix A.

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[8] The chosen specification is given in Appendix B. More precise, the model selection criterion determines the lag length of each dependent variable and whether quarterly dummies, a linear trend term and/or a quadratic trend term should be included.

[9] Since we found the results to test and estimate cointegration relationships to be not robust, we chose to simply estimate the system in levels. Note that estimation in levels leads to consistent estimates. When it is not known whether the variables are integrated or cointegrated, however, it is not straight forward to determine the appropriate penalty terms in the model selection procedure. For example, parameters corresponding to integrated variables that are not cointegrated converge at rate $T$ and should for this reason obtain a smaller penalty term. We chose to assign equal penalty terms to all variables and thus assign a penalty term that is higher than the (asymptotically) correct one to integrated variables that are not cointegrated. If integrated variables that are not cointegrated are less likely to exhibit short-term dependence, then our choice of penalty terms is a sensible one.

*The effects of a monetary tightening*

We start by describing the effects of a monetary tightening on variables other than bank loans. Each figure presents the results for the two VAR specifications. In Figure 4 we plot the path of the federal funds rate in response to a one standard deviation shock to after a sudden monetary tightening. For both VAR's a one standard deviation monetary policy shock leads to a approximately a one percentage point increase in the federal funds rate that dies out in roughly three years. Figure 5 plots the response of the aggregate price level. There is slightly more difference between the responses of the two empirical specifications, but in both systems the price level increases after a sudden monetary tightening.[10] The literature refers to this positive response as the price puzzle. Including the price index for sensitive commodity prices doesn't solve the price puzzle as it does in samples that contain earlier data. Also note that Barth and Ramey (2001) show that including the index of sensitive commodity prices results in a sticky aggregate price level only because the positive and negative sector responses average out, not because sector prices are sticky. Blinder (1987) argues that prices could possibly increase after a negative monetary policy shock if a reduction in the supply of credit leads to a reduction in the supply of output. There also is the possibility that the positive price level responses are due to measurement errors in the construction of the monetary policy shock. The monetary authority tends to raise interest rates during periods of rising prices. This effect is supposedly taken out in the VAR and in this respect it is interesting that the price puzzle is less

[10] Note that the increase is very small. The maximum increase in the price level is less than 0.6% for the four-lag (AIC) VAR and less than 0.2% for the two-lag VAR.

problematic in the VAR specification that is more carefully chosen. If this effect is not taken out completely, however, it would be part of the measured monetary policy shock. If so then the positive prices are not the response of the monetary policy shock, but are rather just the continuation of rising prices to which the federal funds rate has responded. Finally, figure 6 documents that real aggregate personal income drops in response to a monetary tightening.

*Bank loan behavior during monetary and non-monetary downturns*

Figure 7 graphs the response of interest rates during a non-monetary downturn. The figure shows that in response to the economic downturn there is a small reduction of the federal funds rate. Since income is identical during the two types of recessions, the behavior of interest rates is the main difference. Panels A, B and C of Figure 8 compare the behavior of the three loan components during a monetary and a non-monetary downturn when the fixed-two-lag VAR is used to calculate impulse response functions. Panel A plots the behavior of aggregate real estate loans during a monetary and a non-monetary downturn. Consistent with typical views of bank loans during the monetary transmission mechanism we see that real estate loans indeed decrease more during monetary downturns than during non-monetary downturns. In contrast, Panel B documents that commercial and industrial loans decrease sharply during non-monetary downturns while during monetary downturns they show a modest increase. Panel C documents that consumer loans like real estate loans decrease more during a monetary downturn. Figure 9 shows that the differential behavior of real estate loans and commercial and industrial loans across the two types of economic downturns are

similar when the variable-four-lag specification is used to estimate the impulse response functions.

Several other authors have found that short-term lending increases after a monetary contraction[11]. Bernanke and Gertler (1995) point out that these "perverse" movements in credit aggregates are not inconsistent with the bank lending channel if the need to finance inventories and wage payments during periods of falling sales caused the demand for loans to increase by an even greater amount. The moderate increase in commercial and industrial loans after a monetary contraction would then still be consistent with lending constraints. The empirical finding that commercial and industrial loans drop substantially during non-monetary downturns at least questions the view that bank lending is more constrained during monetary downturns than during non-monetary downturns.

If demand for loans is mainly affected by income and interest rates then the finding that after correction for the change in income commercial and industrial loans increase during periods of high interest rates may seem puzzling since high interest rates are unlikely to increase the demand for loans and several papers in the literature argue that the supply of bank loans increases when bank reserves and checkable deposits decrease. Considering prices only makes it more difficult to explain the income-corrected increase of commercial and industrial loans through demand effects. Typically it is believed that a monetary tightening corresponds with sluggish or decreasing price levels, which should result in an even larger increase in the real rate.

[11] Bernanke and Gertler (1995), Christiano, Eichenbaum, and Evans (1996), Gertler and Gilchrist (1994, 1995) and Friedman and Kuttner (1993).

But even for the observed price level predicted in this VAR real rates increase during a monetary downturn and decrease during a non-monetary downturn.

Although the income process is by construction identical in the two recessions, expectations are not since the non-monetary downturn consists of a series of shocks whereas the monetary downturn is caused by a shock in only one period. If the non-monetary downturn is thought to be more persistent than the monetary downturn than it is not that surprising that firms' demand for loans decrease more during a non-monetary downturn. In this respect it is helpful that the persistence of income in response to the identified income shocks differs substantially across the two VAR specifications. While the income response to a real shock is more persistent than the income response to a monetary shock in the fixed-two-lag specification, the opposite is true for the variable-four-lag specification. This is documented in Figure 10. Nevertheless for both VAR specifications we found that commercial and industrial loans show a substantial decrease during the hypothetical non-monetary downturn. Commercial and industrial loans essentially follow real income. This is documented in Figure 11 that plots the responses of income and commercial and industrial loans to a *one-time* negative one standard deviation shock. Panels A and B document the results for the fixed-two-lag and the variable-four-lag specification respectively. It basically shows that in the response to real shocks it is the case that if income reverts faster to its original level, then commercial and industrial loans do as well, while if income reverts slower commercial and industrial loans revert slower.

The finding that non-monetary shocks have less persistent effects on real income is a much more robust finding when we consider shocks to regional income.[12] Nevertheless, we still find the same differential behavior for the loan components across the different recessions as is observed in this section. We, therefore, don't believe that the demand for commercial and industrial loans is higher during non-monetary downturns because agents believe such recessions to be more temporary.

If demand for commercial and industrial loans drops during a monetary downturn and the observed level of industrial loans is relatively stable or slightly increases, the question arises whether the supply of commercial and industrial loans increases. The notion that banks increase the supply of commercial and industrial loans during a monetary tightening, however, stands in stark contrast with both the bank lending view, that maintains that the supply decreases, and their opponents who either argue that there is no change in the supply of bank loans or that there is a reduction in the supply but that it doesn't affect real activity. In the next section, we use a simple theoretical framework to show that in the presence of those frictions that are used in the literature to explain that *total* loans decrease during a monetary downturn, banks would substitute out of real estate loans and increase the supply of commercial and industrial loans.

## 3. Increases in C&I Loan Supply during a Monetary Tightening: An Explanation

In this section we develop a theoretical framework to explain the observed substitution out of real estate bank loans into commercial and industrial loans during

[12] See Section 4.

periods of high interest rates. We start in Section 3.1 by considering several alternative explanations and providing some more empirical information to evaluate their plausibility. A key empirical finding is that during periods of tight money the term premium decreases which reduces the profitability of real estate loans relative to commercial and industrial loans. In Section 3.2, we analyze in a theoretical framework the conditions under which a declining term premium should lead to a substitution out of real estate loans into commercial and industrial loans.

### 3.1. Alternative explanations for the substitution between loans

Since the substitution out of real estate loans into commercial and industrial loans is even stronger when the loan responses are corrected for the changes in income one cannot argue that the demand for commercial and industrial loans increases during periods of economic downturn while the demand for real estate loans decreases during periods of economic downturn. It is, however, possible, that the demand for real estate loans is extremely sensitive to the interest rate and the demand for commercial and industrial loans is not. The lack of demand for real estate loans then forces banks to find other uses for their funds. It is also possible that banks shift the supply of loans towards commercial and industrial loans because of changing risk characteristics. Figure 12 plots delinquency rates of the three loan components for the available sample period after the HP-filter is used to detrend the data. The cyclical behavior of delinquency rates over this short sample period suggests that the risk of real estate loans increases more over the cycle but the differences with the risk of commercial and industrial loans seems minor. Figure 13 plots charge-off rates for the three loan

components. For this series the risk of commercial and industrial loans increases the most during the recession of the early 1990's and seems slightly more cyclical. The relevant question here though is whether during periods of high interest rates (keeping real income constant) the risk of real estate loans increases relative to the risk of commercial and industrial loans. When we estimate a VAR for the short sample for which the risk measures are available, results not reported here can be summarized as follows.[13] When charge-off rates are used as the risk measure, we find that the relative risk of commercial and industrial loans increases during periods of high interest rates.[14] When delinquency rates are used, the relative risk of commercial and industrial loans again increases for several quarters after the initial increase in interest rates but is then followed by a period during which the relative risk of real estate loans is higher. These results, thus, do not provide support for the hypothesis that the relative risk of real estate loans increases during periods of high interest rates, but given the short sample we have to be careful not too much weight on these findings. The results do not seem implausible to us, because a substantial fraction of real estate loans have fixed rates and, thus, should not be affected by an increase in current interest rates (keeping income constant).

The last candidate we consider as an explanation for the change in the relative supply of loan components is a change in interest differentials. In Figure 14 we plot the responses of the average rate on commercial and industrial loans and the average

[13] The samples are the periods from 1985:1 to 2000:2 and from 1987:1 to 2000:2 for charge-off rates and delinquency rates, respectively. We tried several VARs but to increase power we always excluded the mortgage rate, the rate on c&i loans, consumer loans and the price level. Two lags are used in each VAR. The conclusions are robust to including three lags and excluding the loan series.

rate on 30-year mortgages together with the response of the federal funds rate. We observe that while the rate on commercial and industrial loans moves quite closely with the federal funds rate, the increase in mortgage rates is much smaller. This is, of course, not surprising since mortgages are a long-term interest rate. The graph also plots the theoretical response of the rate on a 10-year and 30-year debt instrument when the expectations hypothesis holds. These two rates are even less responsive than the rate on a 30-year mortgage. This suggests that mortgages are a good investment for banks during periods of rising federal funds rates.

The finding that real estate rates are less responsive than rates on short-term debt instruments implies that *current-period* bank profits come under pressure, during periods of high interest rates, since banks finance long-term assets with short-term liabilities. Banks may want to avoid these downfalls in profits even when they are temporary. One reason might be that low profits would affect the bank's capital position and the bank's capital position affects the ability of the bank to issue loans. This is true especially after the implementation of the Basle accord in the beginning of the 1990's but is also thought to have been relevant before the implementation. We formalize these ideas in the theoretical framework developed in the next section.

We want to point out that even when commercial and industrial loans do not fall during a monetary contraction, it still may be the case that some bank dependent firms are denied credit. In fact, a former loan officer[15] suggested that an explanation for our findings is that during periods of high interest rates it becomes profitable for

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[14] That is, the relative risk increases more during a monetary downturn than during a non-monetary downturn.

[15] George Gibson.

banks to issue loans to large and safe clients while during periods of low interest rates banks cannot offer competitive rates to these firms with access to the commercial paper market. The relatively stable stock commercial and industrial loans might, thus, be an increase in lending to new (safe) clients and a decrease in lending to less desirable clients.

### 3.2. Declining term premium and the supply of loan components

In this section we develop a simple theoretical model to understand when and why banks would want to substitute out of long-term loans (real estate loans) into short-term loans (commercial and industrial loans). The model is a two-period model in which the interest rate increases in the first period and remains unchanged in the second period. The length of the period, thus, corresponds to the time the federal funds rate remains high during a monetary tightening. Banks invest in one-period loans, $L_1$, and two-period loans, $L_2$. Banks finance loans by checkable deposits, $D$, and time deposits, $T$. Checkable deposits are subject to a constant reserve requirement. The amount of reserves $R$ thus satisfies the following equation:

(3.1) $$R = \theta D.$$

Deposits earn no interest but the rate of return on time deposits is equal to $r > 0$. In the benchmark version of the model the banks have unlimited access to time deposits at the market rate $r$ and the benchmark version of this model, thus, doesn't have a bank lending channel. We assume that banks have some monopolistic power and that their demand for one-period loans is determined by the following equation:

(3.2) $$r_1 = \lambda r + \beta_0 - \beta_1 L_1.$$

We assume that $\lambda < 1$ so that an equal increase in both $r_1$ and $r$ decreases the demand for loans. Similarly, the demand for two-period bonds is given by

(3.3) $$r_2 = \lambda(r+r')/2 + \beta_0 - \beta_1 L_2,$$

where $r'$ is the interest rate in the second period. Note that the demand function for two-period bonds is identical to that of one-period bonds except that the benchmark interest rate is different. For one-period loans it is the current rate on one-period time deposits and on two-period loans is it the two-period rate according to the expectations hypothesis.[16]

The demand for checkable deposits is given by

(3.4) $$D = \alpha_0 - \alpha_1 r.$$

In the second period the bank can no longer issue two-period loans but can issue still one-period loans. For the second period, we therefore have the following set of equations.

(3.5) $$R' = \theta D',$$

(3.6) $$r_1' = \lambda r' + \beta_0 - \beta_1 L_1', \text{ and}$$

(3.7) $$D' = \alpha_0 - \alpha_1 r'.$$

The banks maximization problem is as follows:

$$\max_{L_1, L_2, T, L_1', T'} r_1 L_1(r_1) + r_2 L_2(r_2) - Tr + \frac{r_1' L_1(r_1') + r_2 L_2(r_2) - T' r'}{1+\rho}$$

$$\text{s.t.} \quad L_1 + L_2 = (1-\theta)D + T \text{ and}$$

$$L_1' + L_2 = (1-\theta)D' + T'.$$

[16] Since there is no uncertainty in this model this would be the appropriate benchmark.

The parameter $\rho$ is the discount rate of the bank. The three first-order conditions are the following:

(3.8) $$r_1(L_1) + \frac{\partial r_1}{\partial L_1} L_1 = r \ ,$$

(3.9) $$r_1(L_1') + \frac{\partial r_1'}{\partial L_1'} L_1' = r' \text{, and}$$

(3.10) $$\left( r_2(L_2) + \frac{\partial r_2}{\partial L_2} L_2 \right)\left( 1 + \frac{1}{1+\rho} \right) = r + \frac{r'}{1+\rho}$$

Equations (3.1) through (3.10) specify a system in the 10 unknowns $r$, $r_1$, $r_2$, $D$, $L_1$, $L_2$, $r'$, $r_1'$, $D'$, and $L_1'$ for given values of $R$ and $R'$.

In this model we don't consider the effect that interest rates might have on income and we don't consider the effect that loan demand is affected by income. The reason is that we are interested in the effect of increases in the interest rate on loan components for a fixed level of income. Also note that in this model the government can obtain a target interest rate level by changing the amount of reserves. Given a target level of the interest rate, the corresponding level of reserves determines then the supply of checkable deposits. The equilibrium condition for checkable deposits then determines the interest rate $r$. Finally, for a given market interest rate and amount of checkable deposits the bank's first-order condition determines the loan supply.

We will consider the effect of an interest rate increase or monetary tightening on the supply of loans for several different cases. A monetary tightening is a change in reserves such that the interest rate $r$ in the first period increases but remains unchanged in the second period. Before we do this it might be worthwhile to consider the case

where in response to an increase in $r$, next period interest rate, $r'$, and the discount rate, $\rho$, increase by the same amount, that is, $dr' = dr$ and $d\rho = dr$. In this case both short-term and long-term loans decrease by the same amount. That is,

$$\frac{dL_1}{dr} = \frac{dL_2}{dr} = \frac{dL_1'}{dr}. \tag{3.11}$$

Now we will consider temporary increases in the interest rate. In the first case banks maximize the objective specified above and have unlimited access to time deposits. Romer and Romer (1990) point out that access to time deposits shelters a bank's loan portfolio when reserves (and thus checkable deposits) decrease and eliminate the bank lending channel. In the other cases we alter these assumptions.

*Case I*: *Access to time deposits and life-time profit maximization.*

In the experiment considered we assume that only $r$ changes and that $r'$ remains the same.[17] It is not hard to show that in general[18] short-term loans decrease <u>more</u> than long-term loans. That is,

$$\frac{dL_1}{dr} < \frac{dL_2}{dr} < 0. \tag{3.12}$$

The intuition for this result is the following. If the interest rate on time deposits increases, the marginal cost of loans increase. To increase the marginal revenue banks have to lower the supply of loans, which will increase the interest rate earned. They do not have to lower the supply of two-period loans by the same amount as the supply of

[17] If the shock occurs when $r = r' = \rho$ then a change of $\rho$ has no effect.
[18] The results hold as long as $1-\lambda-\lambda\rho/2 > 0$ which will be satisfied unless an equal increase in all interest rates have hardly any effect on loan demand.

one-period loans because a decrease in two-period loans will increase the earned interest in two periods while the marginal cost increases only in the first period.

This result is of course the opposite of what we want because we found that real estate loans decreased more than commercial and industrial loans. Moreover, we found that commercial and industrial (or short-term) loans increased in response to an increase in interest rates.

*Case II*: *Access to time deposits and current-period profit maximization.*

In the second case we consider the assumption that banks maximize only current-period profits. Although not part of this model, it is not unreasonable to assume that banks care not only about life-time earnings. Temporary losses, even if they are followed by future offsetting profits, may be harmful for banks because it lowers their equity position temporarily, which in turn can affect their ability to satisfy regulations or more generally their ability to do business. The assumption that banks only care about current-period profits is, of course, an extreme case and only used to clarify the argument. The first-order conditions for the supply of this period's loan components are now given by

(3.13) $$\lambda r + \beta_0 - \beta_1 L_1 + \frac{\partial r_1}{\partial L_1} L_1 = r \text{ and}$$

(3.14) $$\lambda \frac{r + r'}{2} + \beta_0 - \beta_1 L_1 + \frac{\partial r_1}{\partial L_1} L_1 = r \,.$$

In response to an increase in the interest rate two-period loans now decrease more than one-period loans. That is,

(3.15) $$\frac{dL_2}{dr} < \frac{dL_1}{dr} < 0 .$$

The intuition is again relatively simple. Each loan function has a benchmark rate. In the demand function for two-periods loans the benchmark rate is $\lambda$ times a weighted average of this period's and next period's interest rate and in the demand function for one-period loans it is $\lambda$ times the one-period interest rate. When interest rates increase, marginal costs increase but because the benchmark rate increases marginal revenues increase as well. Because the benchmark rate increases by less than the interest rate ($\lambda < 1$), marginal revenues are less than marginal costs and banks have to lower the amount of loans to get to the optimum loan supply. In response to an interest rate increase the benchmark of two-period loans increase less than the benchmark rate of one-period loans which means that banks have to decrease the supply of two-period loans by more to get to the optimum loan supply.

Although better, this is still not the desired result. Two-period loans now decrease more than one-period loans, but one-period loans still go down. The reason is that the supply of both loan components is completely independent. The only relevant variable for both loan supplies is the interest rate on time deposits. As long as banks have unlimited access to time deposits, both loan components should decrease when interest rates increase. According to this model, the observed increase in commercial and industrial loans is inconsistent with the premise in Romer and Romer (1990) that banks can attract time deposits during periods of monetary tightening.

*Case III*: *No access to time deposits and current-period profit maximization.*

In this case we assume that banks have no access to (additional) time deposits. In this case the balance sheet constraint of the bank becomes

(3.16) $$dL_1 + dL_2 = (1-\theta)dD$$

and the supply of one-period and two-period loans are no longer independent, which is made clear by the first-order condition:

(3.17) $$r\,(L_1) + \frac{\partial r_1}{\partial L_1} L_1 = r_2(L_2) + \frac{\partial r_2}{\partial L_2} L_2 .$$

Now the model predicts that one-period loans increase as long as deposits don't decrease too much,[19] that is,

(3.18) $$\frac{dL_2}{dr} < 0 < \frac{dL_1}{dr} .$$

To get the desired response in this model one thus needs two types of frictions. First, banks have to care enough about current-period profits to ensure that long-term loans decrease more than short-term loans. Second, banks must be limited in issuing additional time deposits so that they actually would like to decrease their position of long-term loans to finance the relative more profitable short-term deposits.

## 4. The Importance of Bank Loan Supply for Real Activity

In this section we study the behavior of regional income and bank loan components after monetary and non-monetary policy shocks. The goal is twofold. First, we want to examine to what extent the results found above for the aggregate

[19] We need that $\lambda/2 - 2\beta_1(1-\theta)\alpha_1 > 0$.

hold for individual regions. We will show that although there are important quantitative differences across the regional income and loan responses, the qualitative results are very similar. In particular, in all nine census regions we find that during periods of high interest rates commercial and industrial loans increase relative to real estate loans. Moreover, if frictions are important for the observed substitution into commercial and industrial loans, then one would expect to find the substitution to be stronger in those states where the fraction of loans made by small banks is larger. We document empirical support for this conjecture below.

The second goal of this section is to investigate how important changes in bank loans are for real activity. The observed quantitative differences in the substitution effect into commercial and industrial loans allows us to answer this question and we find that in those regions in which the substitution effect is the stronger are also the regions in which the reduction in income after a monetary tightening is the smaller.

In Section 4.1 we discuss some key features of the regional data. In Section 4.2 we discuss the empirical framework we use to analyze our panel data set. In Section 4.3 we discuss the behavior of regional variables after monetary and non-monetary shocks. Finally, in Section 4.4 we assess the importance of commercial and industrial loans for real activity.

### 4.1. Descriptive statistics of the data

In this section we use figures and simple descriptive statistics to characterize the disaggregated data used in this paper. The main points of this section are as follows. First, there is a substantial amount of regional variation—the regional

income series as well as the regional loan series contain considerable idiosyncratic components. Second, the time-series patterns observed for the three loan components differ substantially across regions.

The disaggregated systems consist of either the nine census regions or the fifty states and the District of Columbia. Figure 15 indicates the location of the nine census regions.[20] When larger regions are used one can expect the regional financial measures to better correspond to the regional real activity measure since less bank loans will be made to clients outside the region. The advantage of using state-level data, however, is that one has enough regions to test whether observed cross-sectional patterns are significant. We find the results of the two disaggregated systems to be consistent with one another. We therefore use the smaller VAR to graphically illustrate our results and the larger VAR to quantitatively examine cross-sectional relationships.

Figure 16 plots the HP-filtered real income series for the nine census regions and the national aggregate. Although the regional series are clearly correlated, there also are important region specific movements. The clearest example is that of West South Central, which during the second half of the eighties suffered from the falling agricultural and oil prices. Even stronger idiosyncratic components can be found in the time-series for the regional loan variables, as is documented in Figure 17.

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[20] The regions include New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont), Middle Atlantic (New Jersey, New York and Pennsylvania, East North Central (Illinois, Indiana, Michigan, Ohio and Wisconsin), West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota), South Atlantic (District of Columbia, Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia), East South Central (Alabama, Kentucky, Mississippi and Tennessee), West South Central (Arkansas, Louisiana,

Finally, we see that the correlation patterns of the regional income and loan series differ substantially across the regions. We do this graphically by comparing New England and Mid Atlantic. Figure 18 plots the HP-filtered income and loan components for New England and reveals a fairly strong correlation between income and each of the loan components. Figure 19 displays the same series for the Mid Atlantic region and illustrates that in this region all loan components, and in particular commercial and industrial loans, are much less correlated with regional income. In Table 1 we present the correlation coefficients of the regional loan components with income. The table documents that the correlation patterns differ substantially across the regions. For example, although commercial and industrial loans is the loan component that is the least correlated with regional income in every region, it displays strong correlation properties in New England and South Atlantic and hardly any correlation in Mid Atlantic and WS Central.

Table 1: Correlation of Real Regional HP-filtered Income and Loan Components

| Region | C&I | Real Estate | Consumer |
|---|---|---|---|
| New England | 0.66 | 0.72 | 0.65 |
| Mid Atlantic | 0.053 | 0.40 | 0.46 |
| EN Central | 0.33 | 0.51 | 0.76 |
| WN Central | 0.37 | 0.69 | 0.61 |
| S Atlantic | 0.64 | 0.72 | 0.64 |
| ES Central | 0.49 | 0.77 | 0.69 |
| WS Central | 0.12 | 0.31 | 0.48 |
| Mountain | 0.39 | 0.56 | 0.61 |
| Pacific | 0.19 | 0.38 | 0.46 |

Oklahoma and Texas), Mountain (Arizona, Colorado, Idaho, Montana, New Mexico, Utah and Wyoming) and Pacific (Alaska, California, Hawaii, Nevada, Oregon and Washington).

**4.2. Regional empirical framework**

In this section we describe the empirical framework used to analyze the effect of monetary policy shocks on regional and aggregate bank loans and real activity. Because of the large number of variables relative to the number of observations, we cannot use standard empirical techniques. Several studies deal with this dilemma by estimating a separate VAR for each region. In contrast, we estimate one VAR for the complete disaggregated system. This system includes the federal funds rate, the mortgage rate, the rate on commercial and industrial bank loans, the consumer price level, the regional deflated values of the three lending components and the regional real income variables. Even for the system with the nine census regions we have a total of thirty-six regional series and four national price series. To deal with the large set of explanatory variables we assume that only the aggregate values of the income and loan component series appear in the interest rate and price equations. Also, in the regression equation for each regional income and loan component series, we assume that besides the own regional series only aggregate loan and income measures are included. This model is then a restricted VAR on the full set of variables.

Let $L_t^{ci,i}$ stand for the amount of real commercial and industrial loans in region $i$, $L_t^{re,i}$ the amount of real real estate loans, $L_t^{cn,i}$ the amount of real consumer loans and $Y_t^i$ the amount of real personal income. All variables are deflated using the national consumer price index. A bar over a variable indicates that the aggregate measure is being used. The equations for the federal funds rate, $f_t$, the mortgage rate, $r_t^{re}$, the rate on commercial and industrial loans, $r_t^{ci}$, and the price level, $P_t$, are given by:

(4.1) $$f_t = \sum_{q=1}^{Q} B_q^f \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \right]' + u_t^f ,$$

(4.2) $$r_t^{re} = \sum_{q=1}^{Q} B_q^{r^{re}} \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \right]' + u_t^f ,$$

(4.3) $$r_t^{ci} = \sum_{q=1}^{Q} B_q^{r^{ci}} \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \right]' + u_t^f \text{ and}$$

(4.4) $$\ln(P_t) = \sum_{q=1}^{Q} B_q^P \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \right]' + u_t^P .$$

Note that the assumption is made that the price series and the federal funds rate do not depend on the regional composition of real income and loans.

For each region ($i$ = 1 to $I$) we estimate the following equations:

(4.5) $$\ln(Y_t^i) = \sum_{q=1}^{Q} B_q^{Y,i} \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \;\; L_{t-q}^{ci,i} \;\; L_{t-q}^{re,i} \;\; L_{t-q}^{cn,i} \;\; Y_{t-q}^i \right]' + u_t^{Y,i} ,$$

(4.6) $$\ln(L_t^{ci,i}) = \sum_{q=1}^{Q} B_q^{ci,i} \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \;\; L_{t-q}^{ci,i} \;\; L_{t-q}^{re,i} \;\; L_{t-q}^{cn,i} \;\; Y_{t-q}^i \right]' + u_t^{ci,i} ,$$

(4.7) $$\ln(L_t^{re,i}) = \sum_{q=1}^{Q} B_q^{re,i} \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \;\; L_{t-q}^{ci,i} \;\; L_{t-q}^{re,i} \;\; L_{t-q}^{cn,i} \;\; Y_{t-q}^i \right]' + u_t^{re,i} \text{ and}$$

(4.8) $$\ln(L_t^{cn,i}) = \sum_{q=1}^{Q} B_q^{cn,i} \left[ f_{t-q} \;\; r_{t-q}^{re} \;\; r_{t-q}^{ci} \;\; \overline{L}_{t-q}^{ci} \;\; \overline{L}_{t-q}^{re} \;\; \overline{L}_{t-q}^{cn} \;\; \overline{Y}_{t-q} \;\; L_{t-q}^{ci,i} \;\; L_{t-q}^{re,i} \;\; L_{t-q}^{cn,i} \;\; Y_{t-q}^i \right]' + u_t^{cn,i} .$$

Different choices are available for the aggregate measures. The results reported here assume that:

(4.9) $$\overline{L}_t^l = \frac{\left( \sum_{i=1}^{I} \ln(L_t^{l,i}) \right)}{I} \;\; \forall l \in \{ci, re, con\} \text{ and}$$

(4.10) $$\overline{Y}_t = \frac{\left(\sum_{i=1}^{I} \ln(Y_t^i)\right)}{I}.$$

Using these aggregate measures means that our VAR is a standard VAR with the restriction imposed that all *q*-period lagged loan components and all *q*-period lagged income components have the same effect on the regressand with the exception of the lags of those series that are from the same region as the regressand. Yamashiro (2001) considers an alternative system by defining:

(4.11) $$\overline{L}_t^l = \ln\left(\sum_{i=1}^{I} L_t^{l,i} / I\right) \quad \forall l \in \{ci, re, con\} \text{ and}$$

(4.12) $$\overline{Y}_t = \ln\left(\sum_{i=1}^{I} Y_t^i / I\right).$$

The advantage of using these aggregate measures is that bigger regions have a bigger effect on the other regions. In our specification, a 1% increase in any of the other regions' income (or loan) series has the same effect, independent of the size of the region in which the shock occurs. An advantage of using the aggregate measures specified in (4.9) and (4.10), however, is that it leads to a system that is linear in the included variables, which simplifies the calculations.[21] Moreover, Yamashiro (2001) finds in a similar framework that the system that uses the aggregate measures of (4.9) and (4.10) typically has smaller sums of squared residuals and would, therefore, be the preferred system if a model selection criterion were to be used. Which aggregate measures are used, however, is not very important since Yamashiro (2001) also

[21] Although the system is linear in the included variables when (4.9) and (4.10) are used to construct the aggregate measures, the system is still nonlinear in any of the aggregate variables. We discuss in the next section how we deal with this complication.

documents that the impulse response functions for the two systems with the different aggregate measures are very similar. More importantly, Yamashiro (2001) also shows that the impulses responses for the restricted system are similar to those from a less restricted system that is constructed by letting a model selection procedure determine whether additional regional variables should be included as separate regressors.

As above, we summarize the impact of the actions of the FED using impulse response functions. These responses trace out the effects of a one standard deviation shock to the federal funds rate innovation on current and future values of the endogenous variables in the system. The disaggregated system specified above is linear in the three interest rates, the price index, the regional income series and the regional bank loan component series. However, since the system is specified in logarithms, it is nonlinear in the aggregate income and loan variables, as well as in regional total loans. To calculate the impulse response functions for these variables we follow the following procedure. We assume that the regional variables are equal to the observed sample average in the period the shock occurs. Using the impulse response functions for the regional variables it is then easy to calculate the actual regional values in the periods after the shock and by simply adding up across regions we obtain the aggregate values. By calculating the log difference, relative to the aggregate value in the period before the shock, one obtains the impulse response function for the aggregate variable.

**4.3 Regional results**

Figure 20 plots the responses of real personal income in the nine census regions. We observe a substantial amount of dispersion. In three regions, East South Central, East North Central and West North Central we observe the biggest decreases in income and in West South Central income basically does not respond. Even more dispersion is observed when we look at the responses of total loans in Figure 21.

To determine which part of the response in loans is due to a change in income we compare again the behavior of each loan component during a monetary downturn with the behavior during a non-monetary downturn. Now a non-monetary downturn is such that the income response equals that of a monetary downturn in *each* region. Figures 22, 23, and 24 plot the regional loan responses during a monetary downturn relative to the responses observed during a non-monetary downturn, for commercial and industrial loans, real estate loans, and consumer loans, respectively. We see that after the correction for the drop in income, the two-year response in commercial and industrial loans is positive across all nine regions. In contrast, the two-year response in real estate loans is negative in seven of the nine regions. The results are mixed for consumer loans.

Again we want to address the concern that although income levels in all regions are by construction the same in each region, expectations might differ. To shed light on this issue we compare aggregate income after a one-time monetary policy shock with aggregate income after one-time one standard deviation shocks to each of the nine census regions income levels. The responses in Figure 25 document that regional real shocks are not more persistent than monetary shocks and one cannot

explain the relative increase in commercial and industrial in response to monetary shocks to the property that agents believe effects on income to be more temporary during monetary contractions.

*Explaining cross-sectional loan responses*

We begin by calculating the correlation coefficient between the *n*-th quarter cumulative (income-corrected) response of the loan components in state *i* with the fraction of loans issued by small banks in state *i*. The results are reported in Table 2. The table shows that the *in*crease in (income-corrected) commercial and industrial loans and the *de*crease in (income-corrected) real estate loans, consumer loans and total loans are larger in states with a large fraction of small banks. Consistent with the results in Kashyap and Stein (1995) we find that the reduction in total loans is bigger for (states with a large fraction of) small banks.

Table 2: Income-corrected *n*-th period cumulative loan responses
Correlation with the fraction of loans issued by small banks

| *n* | C&I | Real Estate | Consumer | Total |
|---|---|---|---|---|
| 2 quarters | 6.2 | -7.0 | -15.8 | -2.0 |
| 4 | 22.2 | -14.9 | -21.0 | -1.6 |
| 8 | 13.4 | -21.7 | -29.6 | -13.2 |
| 12 | 0.9 | -28.3 | -37.0 | -25.3 |

To further investigate this question we regress the *n*-quarter cumulative response of commercial and industrial loans relative to the *n*-quarter cumulative response of real estate loans on (i) the fraction of manufacturing in state output, (ii) the fraction of small firms, (iii) the fraction of loans made by small banks and (iv) the

average fraction of real estate loans in the loan portfolio.[22] The variables are scaled by the cross-sectional regression, so the coefficient measures the response in the dependent variable (relative to its standard deviation) when the explanatory variable increases with one standard deviation.[23] We see that in states in which the fraction of loans issued by small banks is larger are also the states in which there is a stronger substitution into commercial and industrial loans. None of the other variables are important in explaining the substitution into commercial and industrial loans.[24]

Table 3: Substitution into C&I loans and state characteristics
(regression coefficients, *t*-statistics in parenthesis)

| *n* | manufacturing | small firms | small banks | RE/L |
|---|---|---|---|---|
| 2 quarters | -0.072 | 0.104 | 0.065 | 0.044 |
| | (0.45) | (0.65) | (0.44) | (0.30) |
| 4 | -0.181 | 0.039 | 0.275 | 0.041 |
| | (1.19) | (0.26) | (1.98) | (0.30) |
| 8 | -0.047 | 0.018 | 0.324 | 0.044 |
| | (0.30) | (0.12) | (2.31) | (0.32) |
| 12 | 0.097 | -0.038 | 0.294 | 0.075 |
| | (0.63) | (0.25) | (2.07) | (0.53) |

### 4.4 Cross-sectional dispersion in income and (income-corrected) loan responses

A key question in the literature is whether a reduction in the supply of bank loans worsens the effects of a monetary tightening. Our income-corrected impulses for the loan variables are a natural indicator for the change in the access to bank loans.

[22] Except for the fourth variable these characteristics are from Carlino and Dafina (1998). For the cross-sectional regression Alaska, Hawaii, and the District of Columbia are excluded.
[23] The reported *t*-statistics are for the two-sided test that the coefficient is equal to zero.
[24] Manufacturing has explanatory power for the cross-sectional dispersion in the total loan responses. In particular, the drop in (income-corrected) total loans is bigger in those states with a large fraction of manufacturing. In the same regression, the fraction of commercial and industrial loans has a significant positive effect and the fraction of loans issued by small banks has a marginally significant negative effect.

Since there is a strong spatial link between the location of the borrower and the location of the bank, we can use the heterogeneity observed across regional responses to shed some light on the question whether commercial and industrial loans are important for real activity during the monetary transmission mechanism. However, since we find that the changes in (income-corrected) commercial and industrial loans are positive, the relevant question is whether changes in commercial and industrial loans actually *dampen* the effects of a monetary tightening. The question whether the observed decreases in (income-corrected) real estate loans after a monetary contraction worsen the economic downturn is much harder to answer, since the market for real estate loans does not display the same amount of spatial segmentation as the market for commercial and industrial loans.

We start by looking at the correlation between the *n*-quarter cumulative state income responses and the corresponding (income-corrected) loan responses. The results are reported in Table 4. We observe the strongest positive correlation with commercial and industrial loans and the weakest for consumer loans. Since the market for consumer loans exhibits the least geographical segmentation, these results are not surprising. Ignoring the first few quarters, the correlation coefficients for both commercial and industrial loans and real estate loans are positive. Thus, a higher amount of (income-corrected) loans corresponds with a higher amount of income, for *both* loans components. But since commercial and industrial loans and real estate loans move in opposite directions, the interpretation of these results is that in those regions where the (income-corrected) increase in commercial and industrial loans is the stronger are also the regions where the decrease in real income is the smaller,

while those regions that experience a larger (income-corrected) drop in total loans are also the regions where income drops more.

Table 4: *n*-th period cumulative income and (income-corrected) loan responses
Correlation coefficients

| *n* | C&I | Real Estate | Consumer | Total |
|---|---|---|---|---|
| 2 quarters | 21.4 | 0.5 | -8.7 | 11.1 |
| 4 | 26.1 | -1.8 | -8.1 | 9.3 |
| 8 | 26.6 | 13.8 | 16.0 | 26.1 |
| 12 | 26.7 | 30.7 | 17.4 | 33.4 |

In Table 5 we present the result of the cross-sectional regression where we regress the state income response on the three (income-corrected) loan responses. We see in several regression equations that the response in commercial and industrial loans is positive and significant. Moreover, the observed coefficients for commercial and industrial loans are bigger than for the other two loan components.

Table 5: *n*-th period cumulative state income responses
(Regression on (income-corrected) loan responses, *t*-statistics in parenthesis)

| *n* | C&I | Real Estate | Consumer |
|---|---|---|---|
| 2 quarters | 0.099 | -0.040 | -0.044 |
| | (1.82) | (0.52) | (1.04) |
| 4 | 0.143 | -0.061 | -0.032 |
| | (2.22) | (0.94) | (0.86) |
| 8 | 0.105 | 0.033 | 0.034 |
| | (1.59) | (0.05) | (0.86) |
| 12 | 0.048 | 0.077 | 0.010 |
| | (0.86) | (1.28) | (0.28) |

In Table 6 we report the results of a regression of the *n*-th quarter cumulative state income response on (i) the (income-corrected) change in commercial and industrial loans, (ii) the fraction of manufacturing in state output, (iii) the fraction of small firms and (iv) the fraction of loans made by small banks. The variables are scaled by the

cross-sectional regression, so the coefficient measures the response in the dependent variable (relative to its standard deviation) when the explanatory variable increases with one standard deviation. The table shows that the fraction of small firms does not seem to be a good explanatory variable. The other three explanatory variables, however, are significant at relatively low significance levels. Moreover, the magnitude of the coefficients is substantial. So, although this study does not support the view that bank loans to businesses are constrained during a monetary tightening, they are consistent with the view that bank loans matter.

Table 6: *n*-th period cumulative state income responses
(Regression on state characteristics, *t*-statistics in parenthesis)

| *n* | (income-corrected) Δ C&I loans | manufacturing | small firms | small banks |
|---|---|---|---|---|
| 2 quarters | 0.221 | 0.107 | 0.105 | 0.215 |
| | (1.61) | (0.70) | (0.69) | (1.53) |
| 4 | 0.226 | -0.127 | 0.003 | 0.243 |
| | (1.62) | (0.85) | (0.02) | (1.77) |
| 8 | 0.232 | -0.275 | -0.048 | 0.200 |
| | (1.75) | (1.91) | (0.34) | (1.51) |
| 12 | 0.259 | -0.342 | -0.050 | 0.243 |
| | (2.09) | (2.51) | (0.36) | (1.91) |

Before we interpret these results we want to shed some light on how important the changes in the loan components are quantitatively for state income. To do this we recalculate the income responses for the nine census regions after a monetary policy shock when in each period the response of a loan component is set equal to the response during a non-monetary tightening. Since the VAR is a reduced form framework this is not an ideal exercise. The reason is that if loans really would behave differently during a monetary tightening other things would change also, and

this is not taken into account. Nevertheless, the exercise should give some indication of the quantitative importance of bank loans. Figure 25 plots the two-year cumulative income response when loan responses are equal to the typical values after a monetary downturn and when the indicated loan component has the responses that are observed during a non-monetary downturn. When the responses of commercial and industrial loans are equal to the responses during a non-monetary downturn, which are much more negative, then income decreases more in several regions although the effect is minor. In contrast, when real estate loan responses are equal to the smaller negative responses of a non-monetary downturn then economic activity drops in every state by a larger amount. Thus, although the results above showed that regional real estate loans did not display a strong correlation with regional income, for the nation as a whole real estate loans seem the more important loan variable during a monetary downturn, not only because it does display an atypical decrease but also because its quantitative effects are more important. This finding is, of course, consistent with the observation that housing investment is an important (and volatile) indicator of economic activity.

## 5. Interpretation of results

There are two ways to interpret our findings. One interpretation is that the increase in the amount of (income-corrected) commercial and industrial loans is due to an increase in the supply of commercial and industrial loans, either because banks cannot find demand for real estate loans or because they themselves want to substitute out of real estate loans and into commercial and industrial loans. Furthermore, the

natural interpretation of the observed cross-sectional correlation between state income responses and state (income-corrected) commercial and industrial loan responses under this hypothesis is that the additional supply of commercial and industrial loans is able to dampen the negative consequences of the monetary tightening. This hypothesis is characterized in panel A of Figure 26. Support for this explanation is that the increase in (income-corrected) commercial and industrial loans is stronger in those states where a large fraction of loans is issued by small banks.

An alternative demand-based explanation is given in panel B of Figure 26. Here a monetary tightening leads to an increase in interest rates, which results both in a decrease in real income and a decrease in commercial and industrial loans.[25] Since we have corrected the change in loans for changes in income, one cannot explain the observed correlation between income responses and (income-corrected) loan responses with the theory that the demand for loans by firms whose output is more sensitive to changes in the interest rate is also more sensitive to changes in the interest rate, because these firms need more/less loans when interest rates in/decrease. This is indicated in the figure by the cross through the relevant arrow. Nevertheless, it is still possible that the observed correlation between income changes and income-corrected changes in commercial and industrial loans is due to changes in demand. In particular, suppose that those industries for which output is very sensitive to changes in the interest rate are also the industries for which the demand for commercial and industrial loans is sensitive to the interest rate even when income remains constant. One

[25] In addition one would need an increase in supply to explain the aggregate increase in (income-corrected) commercial and industrial loans, but this increase would have no effect on real activity in this demand-based explanation.

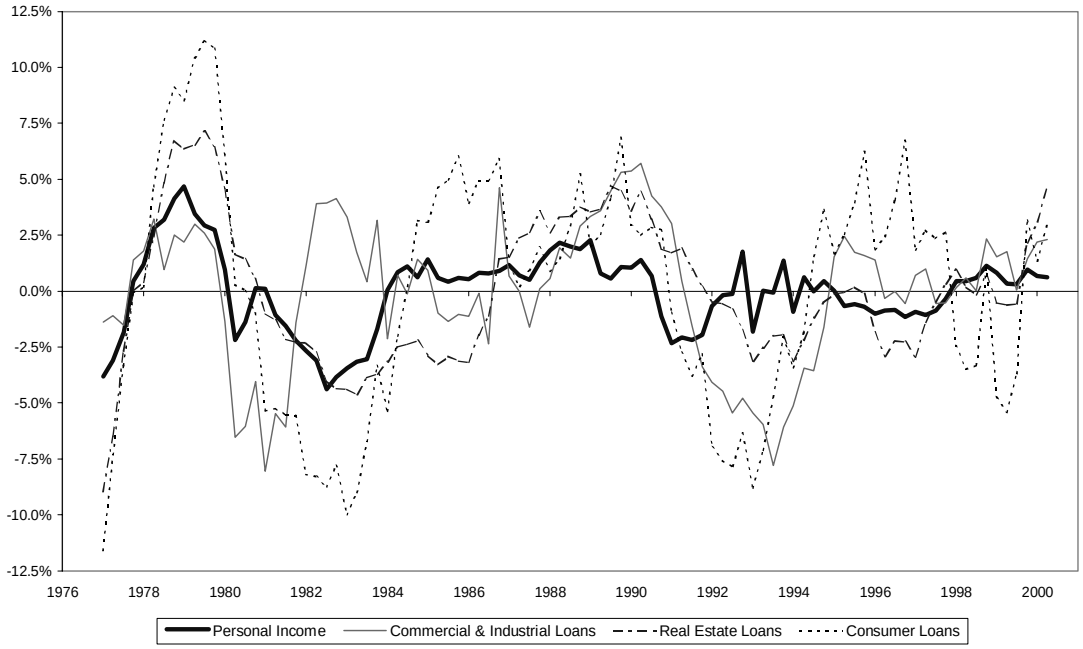
argument in favor of this explanation is that across states, the fraction of manufacturing is correlated with both the change in income and with the income-corrected change in commercial and industrial loans. The observed correlations with manufacturing are not entirely convincing, however, since manufacturing is also correlated with the income-corrected change in real estate loans, and as shown above it is not correlated with the substitution out of real estate loans and into commercial and industrial loans. That the fraction of manufacturing in the state's industry is correlated across states with the observed changes in real estate loans is surprising in and of itself but is especially so since real estate loans are much less linked to the residence of the borrower. An alternative explanation for the finding that a higher concentration of manufacturing firms in a state implies a bigger decrease or smaller increase for all (income-corrected) loan components is the following. If manufacturing is more affected by the higher interest rates (keeping income constant) then banks in states with a higher concentration of manufacturing firms might face a larger number of loan defaults and, thus, a bigger reduction in their capital position. The reduction in the banks' capital position then leads to a reduction in loan supply.

## 6. Concluding Comments

The market for business loans has seen some remarkable changes in the postwar period. Important developments have been the emergence of the commercial paper market, removal of Regulation Q and a reduction of reserve requirement on time deposits. Also, the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1997 virtually eliminated the restrictions on interstate banking, which should make it

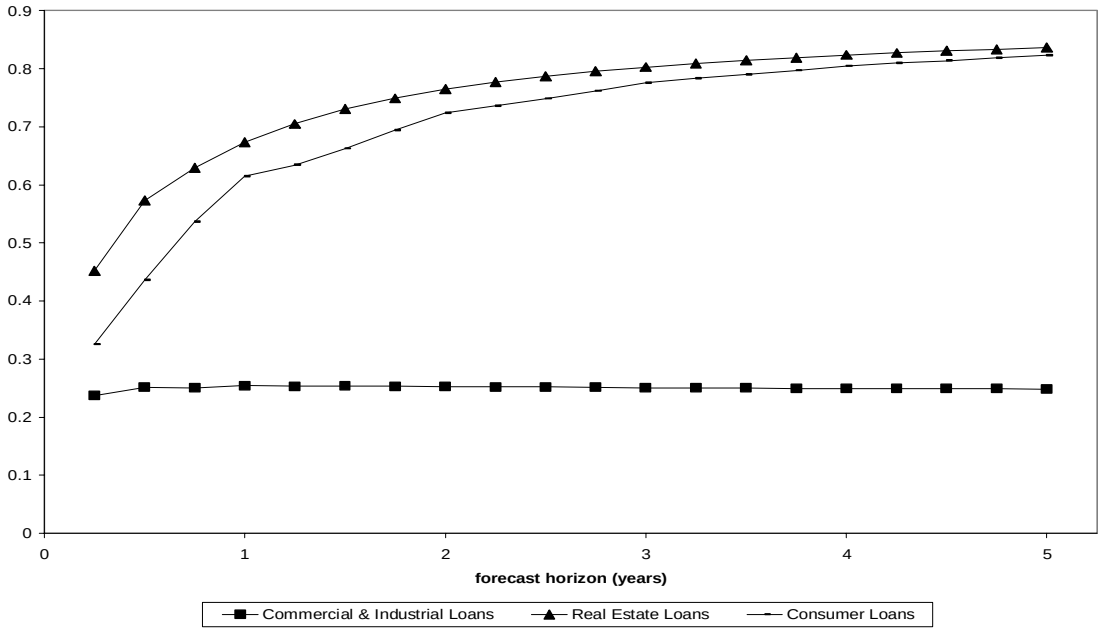
easier for banks to attract time deposits. Since time deposits are not insured, however, informational problems remain and may constrain banks' access to time deposits. In addition, new frictions have been created. One example is the implementation of the Basle accord in the Federal Deposit Insurance Corporation Improvement Act in 1991. This law may constrain commercial and industrial bank loans especially during economic downturns when risk increases and banks' equity falls, since this would make it more difficult for banks to satisfy the required risk-based capital requirement. This institutional change may make it more likely that banks emphasize current period profits, a feature that played a key role in our theoretical framework.

Figure 1: Deflated Aggregate Earnings and Loan Components



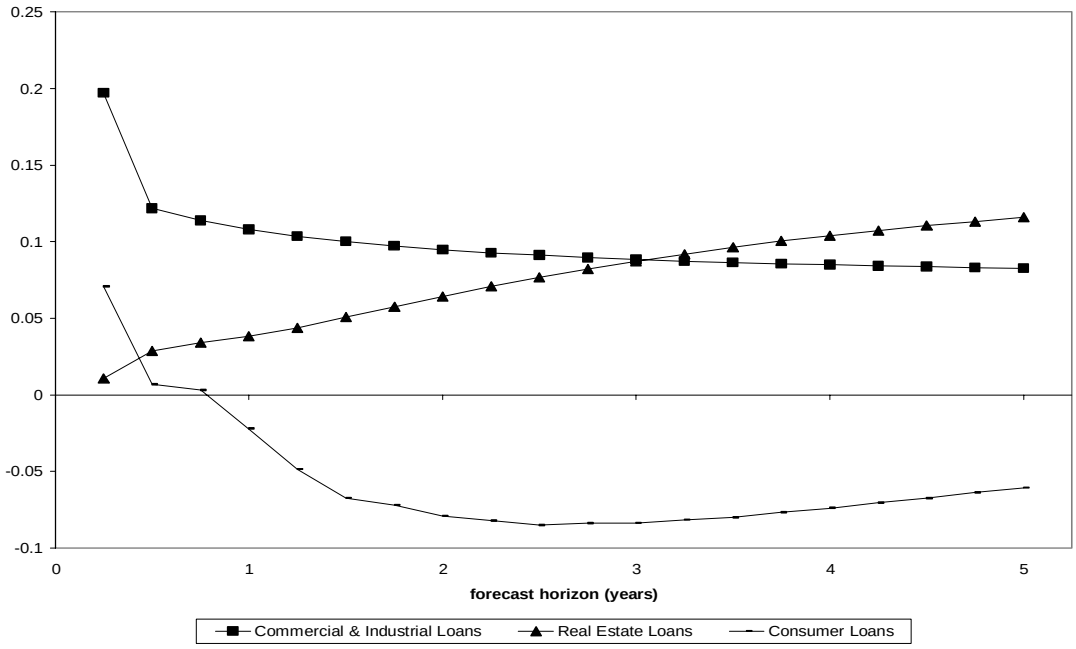

Note: This graph plots the percentage deviation from the trend of the indicated series deflated by the consumer price index when the HP filter is used calculate to the trend.

Figure 2: Comovement between Aggregate Earnings the Loan Components



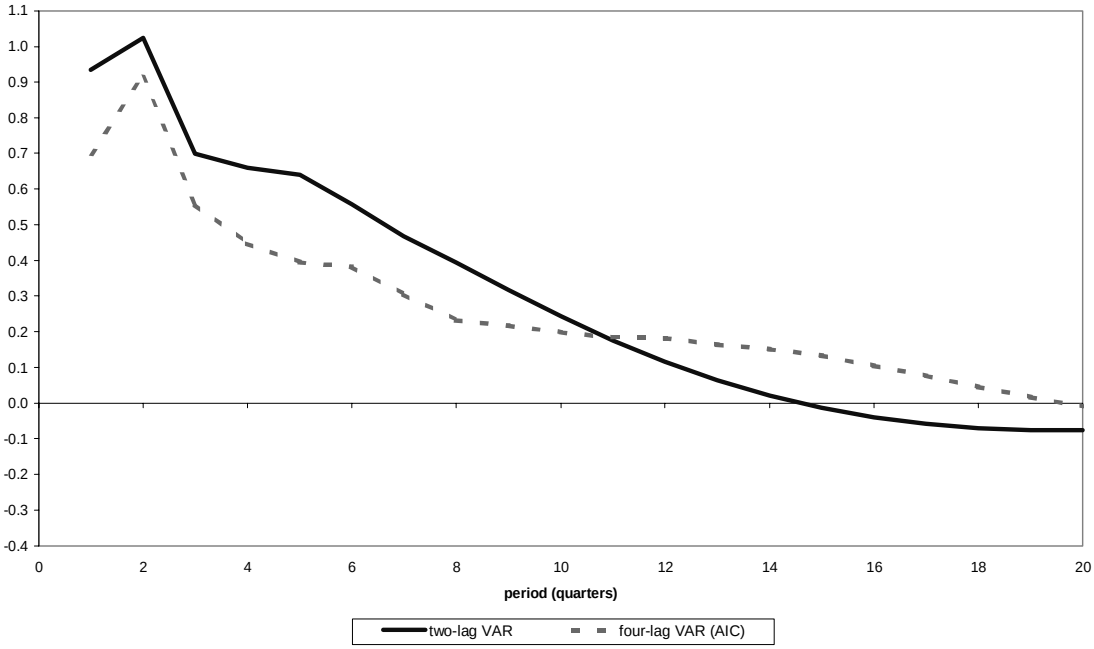

Note: This graph plots the correlations of the forecast errors from three bivariate VAR's. Each VAR includes aggregate income and the indicated component of lending. All variables are in real terms.

Figure 3: Comovement between the Federal Funds Rate and the Loan Components



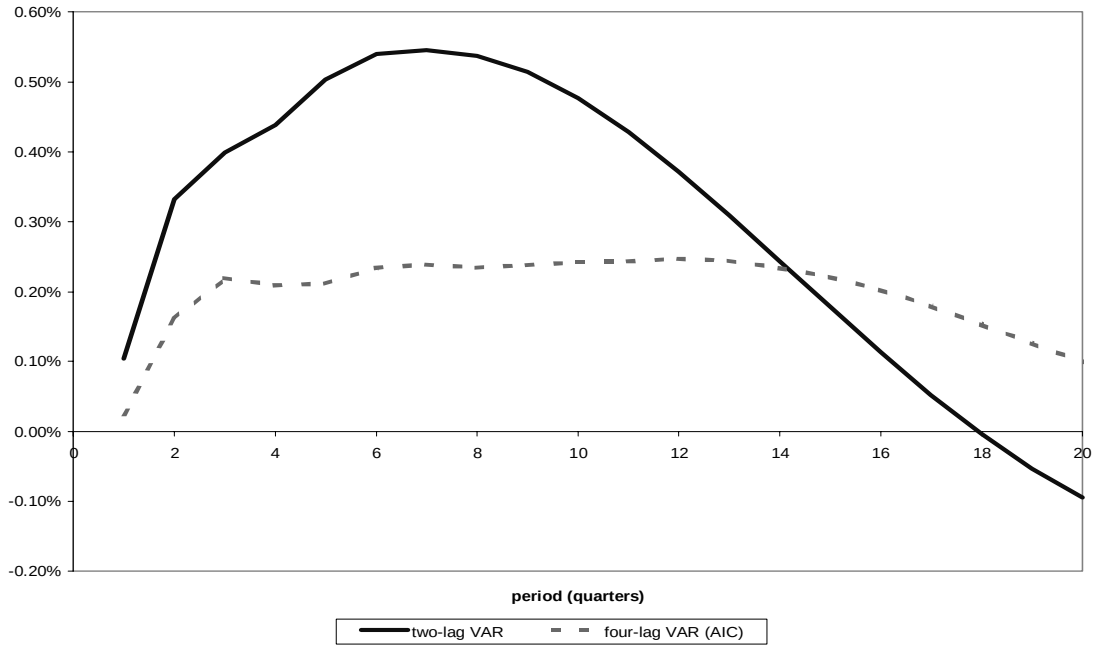

Note: This graph plots the correlations of the forecast errors from three bivariate VAR's. Each VAR includes the federal funds rate and the indicated component of lending. All variables are in real terms.

## Figure 4: Federal Funds Rate after a Monetary Policy Shock



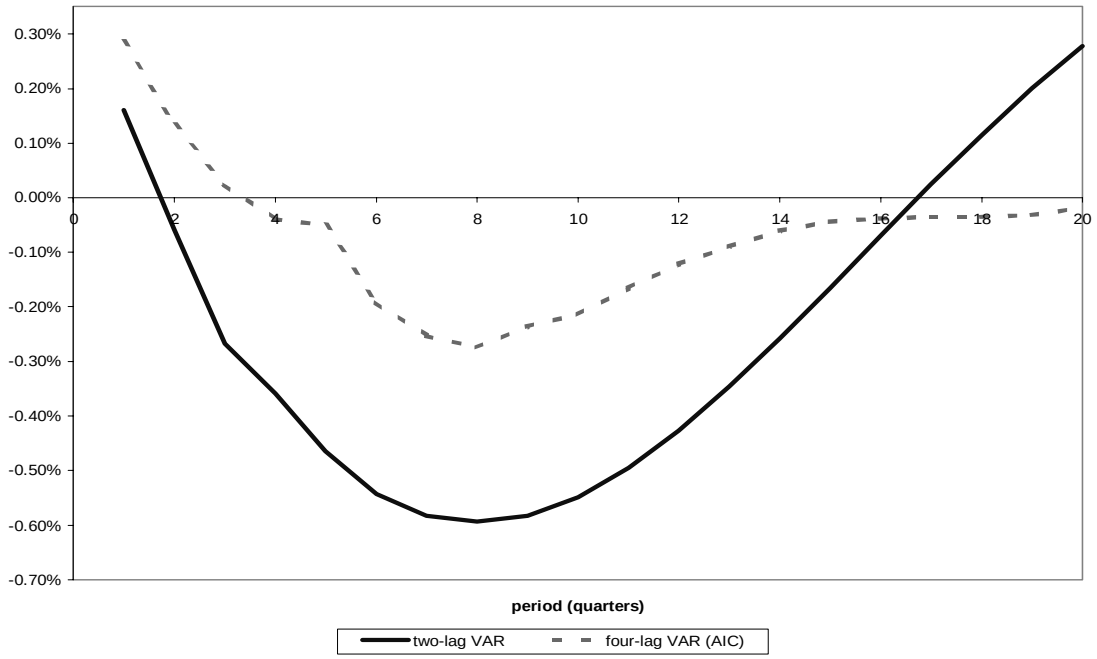

Note: This graph plots the impulse response function of the federal funds rate in response to a one standard deviation shock of the innovation in the federal funds rate equation, when the indicated system is used to estimate the VAR. The impulses are measured in percentage points on an annual basis.

Figure 5: Price Level after a (Negative) Monetary Policy Shock



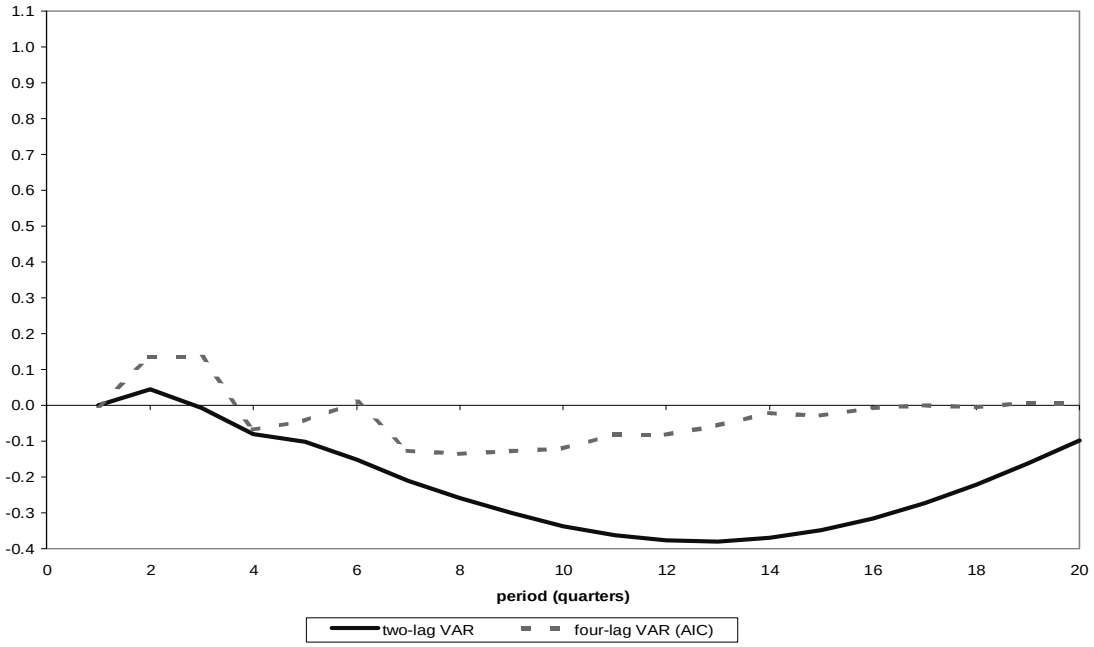

Note: This graph plots the impulse response function of the price level in response to a one standard deviation shock to the innovation of the federal funds rate equation, when the indicated system is used to estimate the VAR.

Figure 6: Aggregate Income after a (Negative) Monetary Policy Shock



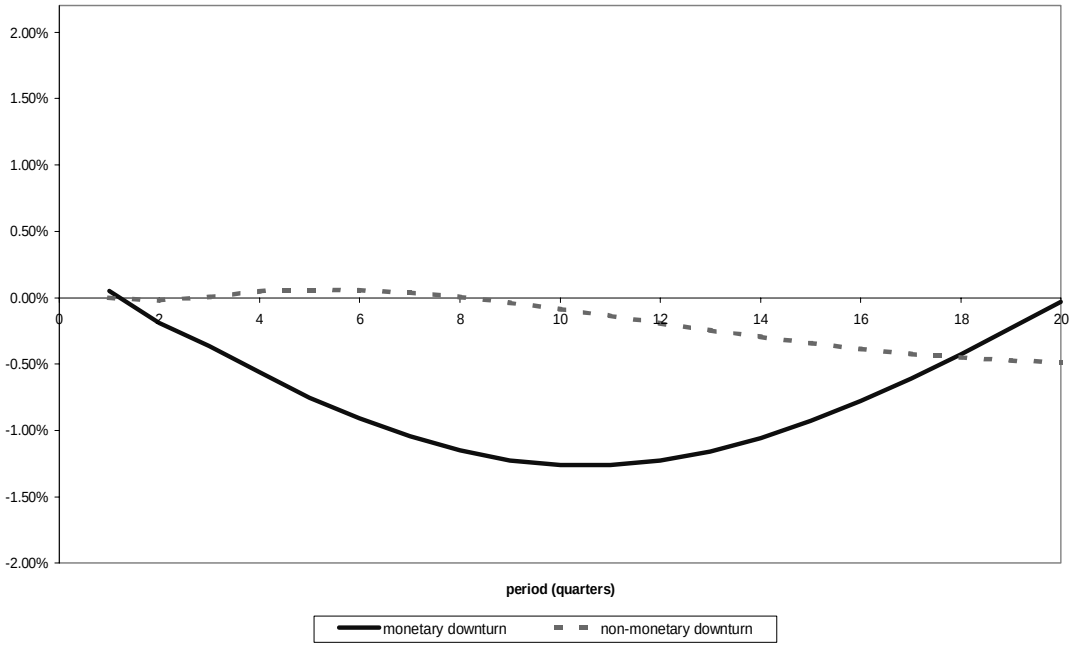

Note: This graph plots the impulse response function of deflated aggregate income in response to a one standard deviation shock to the innovation of the federal funds rate equation, when the indicated system is used to estimate the VAR.

Figure 7: Federal Funds Rate During a Non-Monetary Downturn



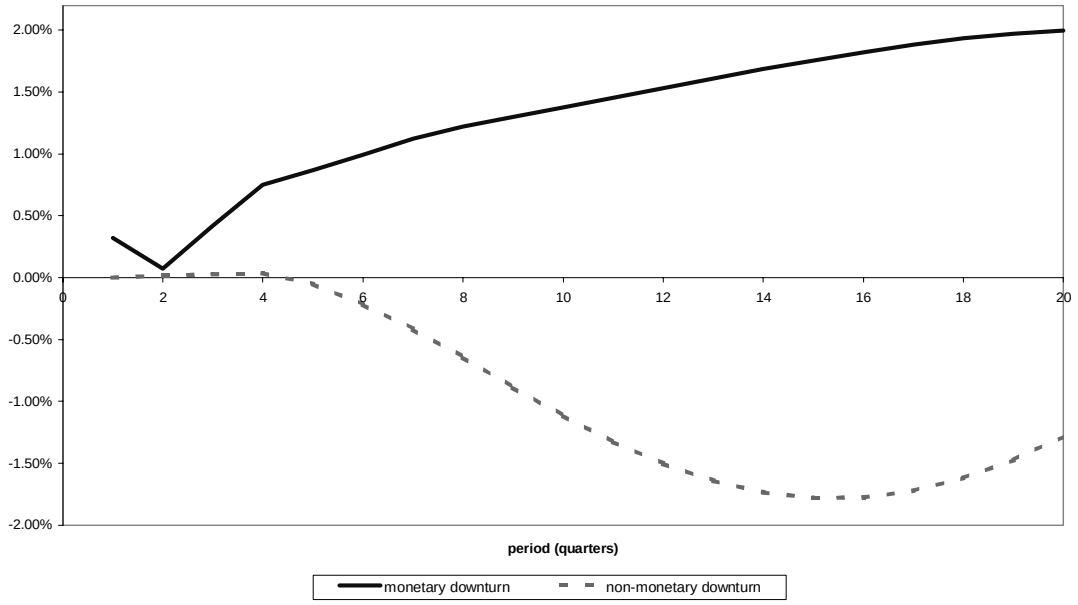

Note: This graph plots the impulse response function of the federal funds rate in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The indicated system is used to estimate the VAR.

Figure 8A: Real Estate Loans During Monetary and Non-Monetary Downturns



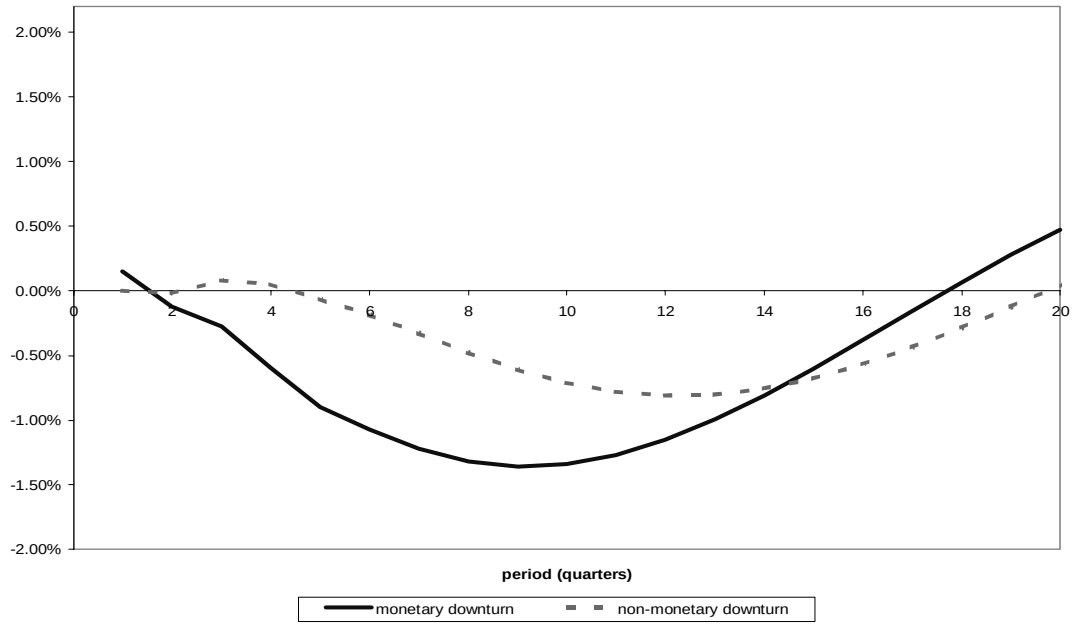

Note: This graph plots the impulse response function of real estate loans in response to a one standard deviation shock to the federal funds rate and the impulse response function in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The fixed-two-lag specification is used to estimate the VAR.

Figure 8B: C&I Loans During Monetary and Non-Monetary Downturns



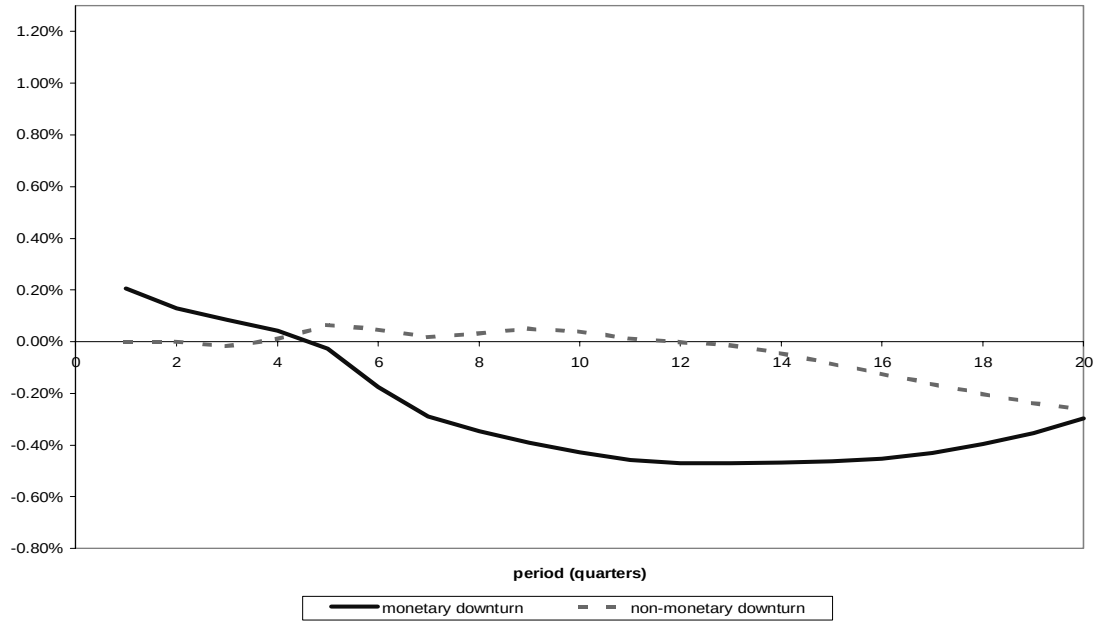

Note: This graph plots the impulse response function of commercial and industrial loans in response to a one standard deviation shock to the federal funds rate and the impulse response function in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The fixed-two-lag specification is used to estimate the VAR.

Figure 8C: Consumer Loans During Monetary and Non-Monetary Downturns



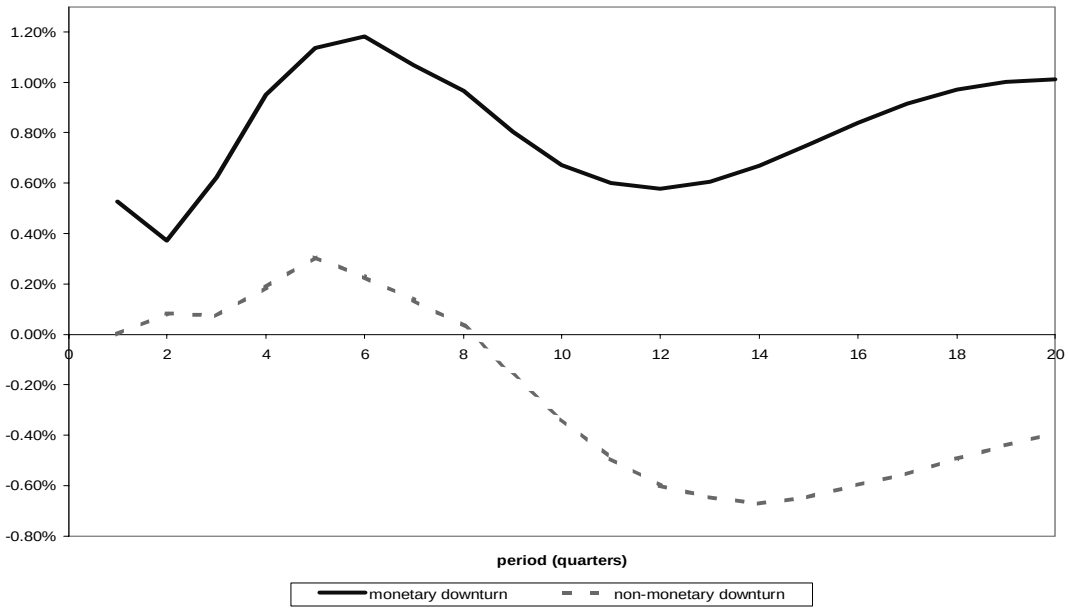

Note: This graph plots the impulse response function of consumer loans in response to a one standard deviation shock to the federal funds rate and the impulse response function in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The fixed-two-lag specification is used to estimate the VAR.

Figure 9A: Real Estate Loans During Monetary and Non-Monetary Downturns



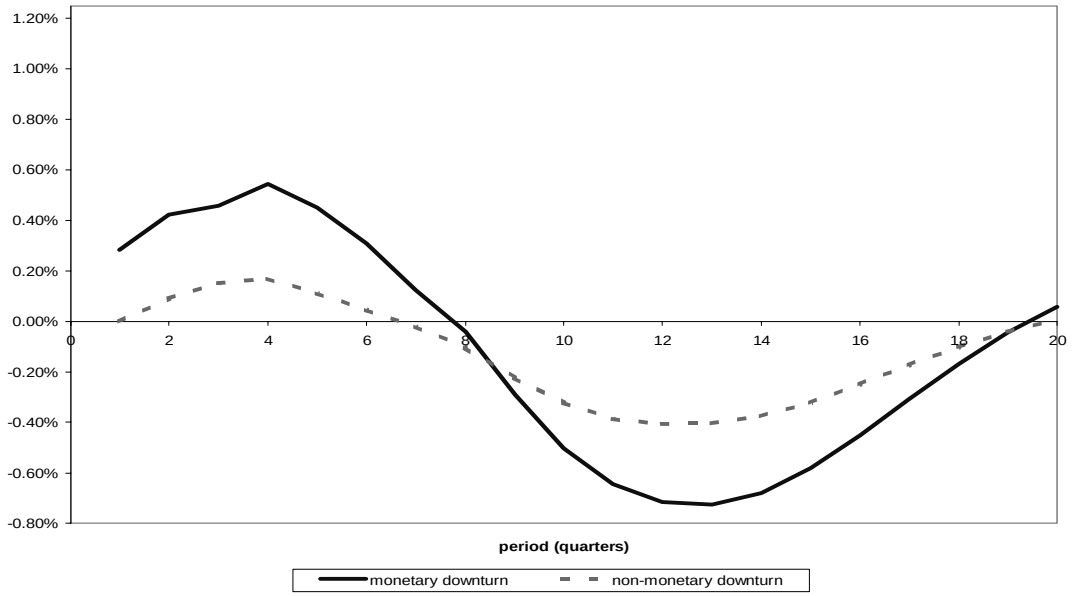

Note: This graph plots the impulse response function of real estate loans in response to a one standard deviation shock to the federal funds rate and the impulse response function in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The variable-four-lag specification is used to estimate the VAR.

Figure 9B: C&I Loans During Monetary and Non-Monetary Downturns



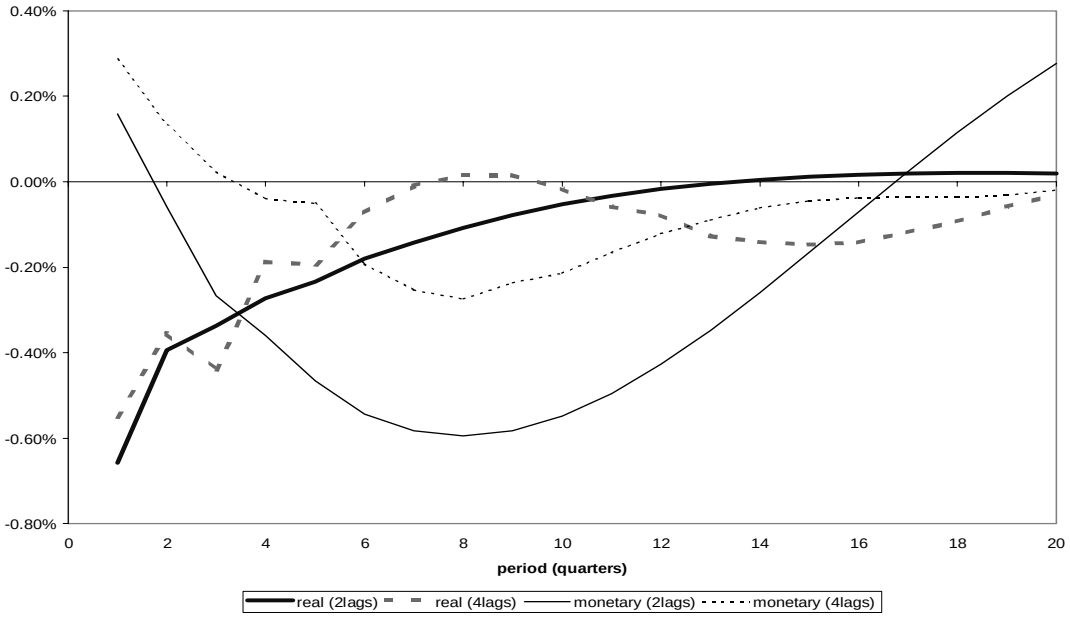

Note: This graph plots the impulse response function of commercial and industrial loans in response to a one standard deviation shock to the federal funds rate and the impulse response function in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The variable-four-lag specification is used to estimate the VAR.

Figure 9C: Consumer Loans During Monetary and Non-Monetary Downturns



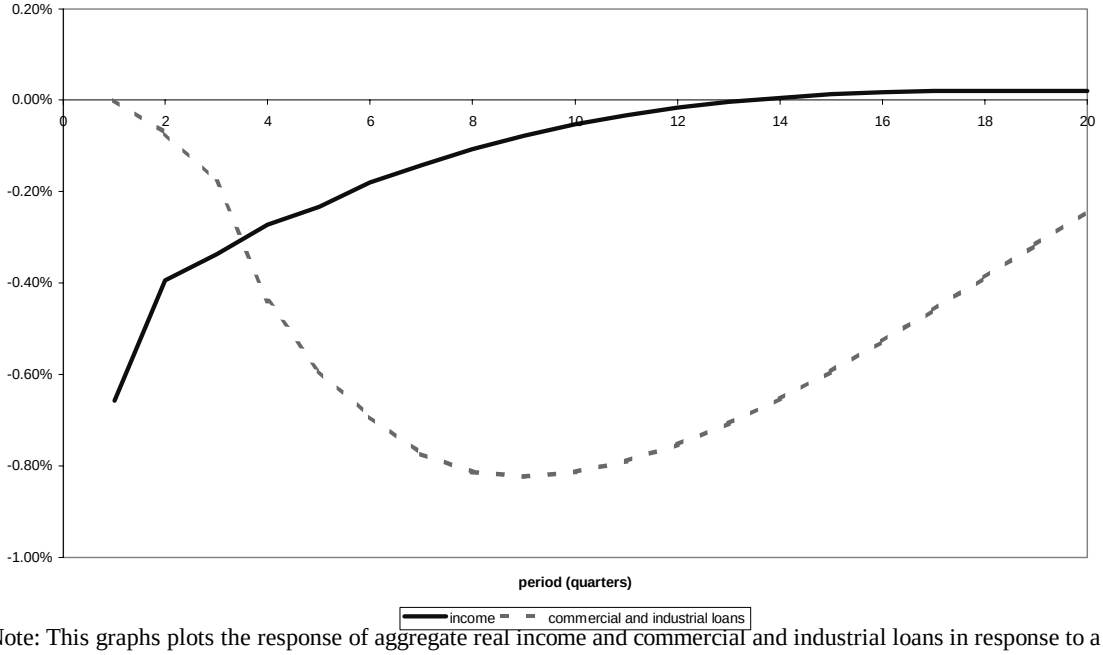

Note: This graph plots the impulse response function of consumer loans in response to a one standard deviation shock to the federal funds rate and the impulse response function in response to a series of income shocks that generate an income time path identical to that observed for a monetary downturn. The variable-four-lag specification is used to estimate the VAR.

Figure 10: Income Responses to One-Time Monetary and Non-Monetary Shocks



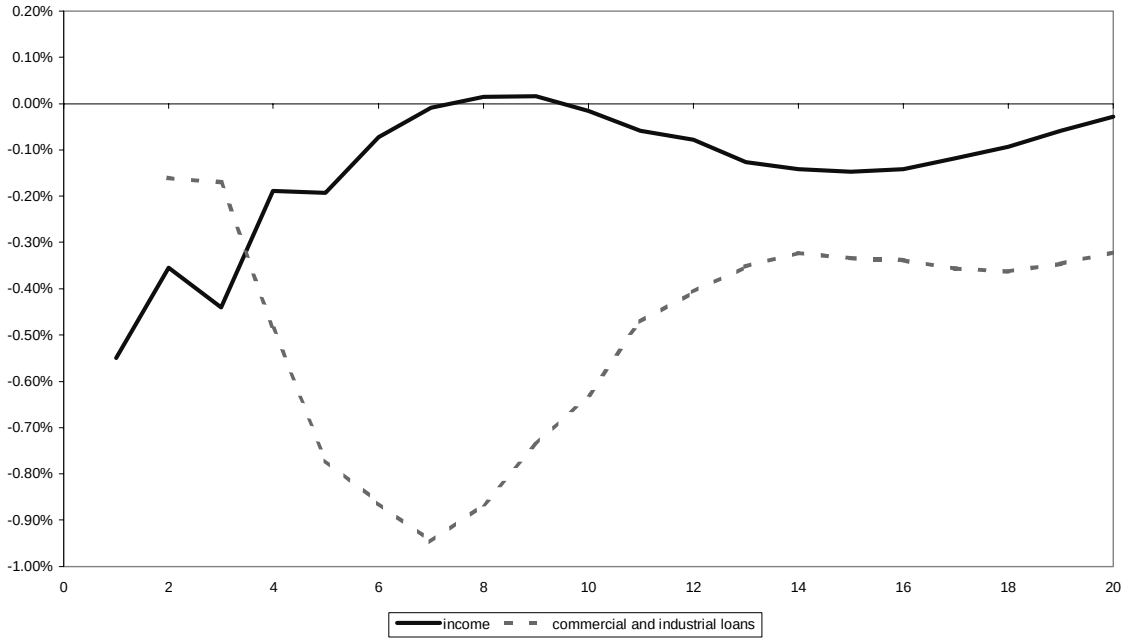

Note: This graphs plots the response of aggregate real income in response to either a one-time positive one standard deviation shock in the federal funds rate or a one-time negative one standard deviation shock in real income for both VAR specifications.

Figure 11A: Income and C&I Loan Responses to One-Time Non-Monetary Shocks



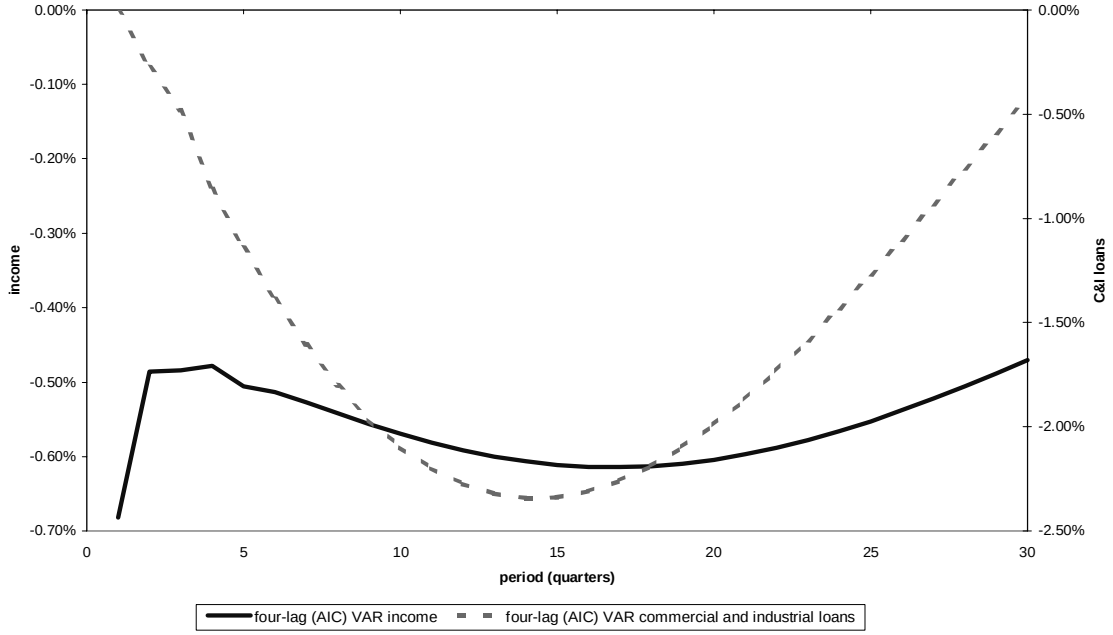

Note: This graphs plots the response of aggregate real income and commercial and industrial loans in response to a one-time negative one standard deviation shock in real income for the fixed-two-lag specification.

Figure 11B: Income and C&I Loan Responses to One-Time Non-Monetary Shocks



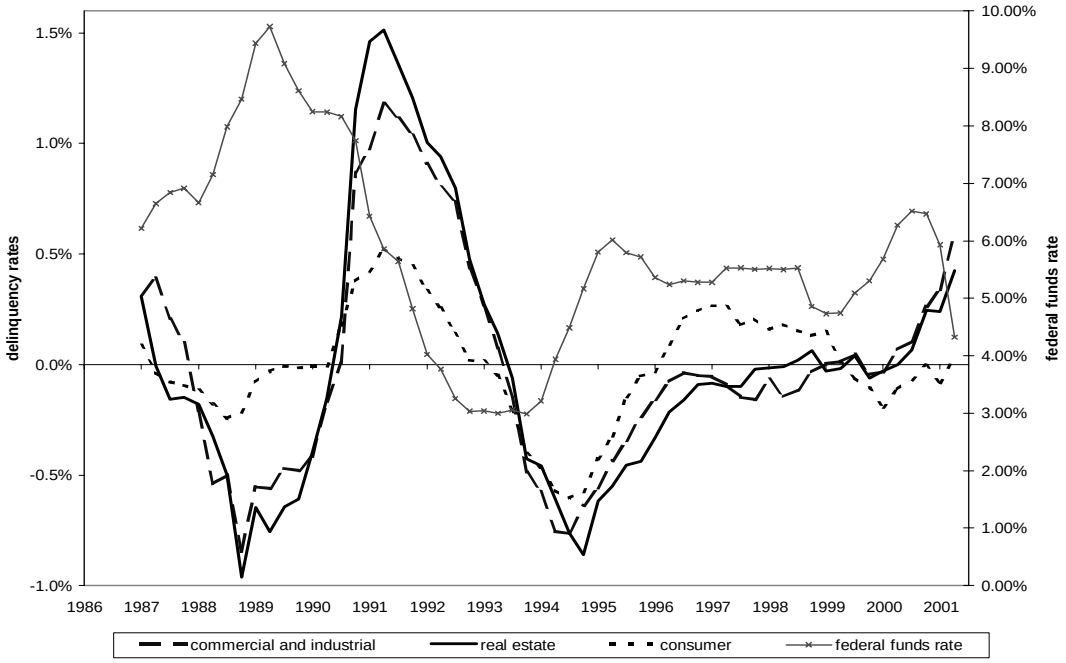

Note: This graphs plots the response of aggregate real income and commercial and industrial loans in response to a one-time negative one standard deviation shock in real income for the variable-four-lag specification.

Figure 11C: Income and C&I Loan Responses to One-Time Non-Monetary Shocks



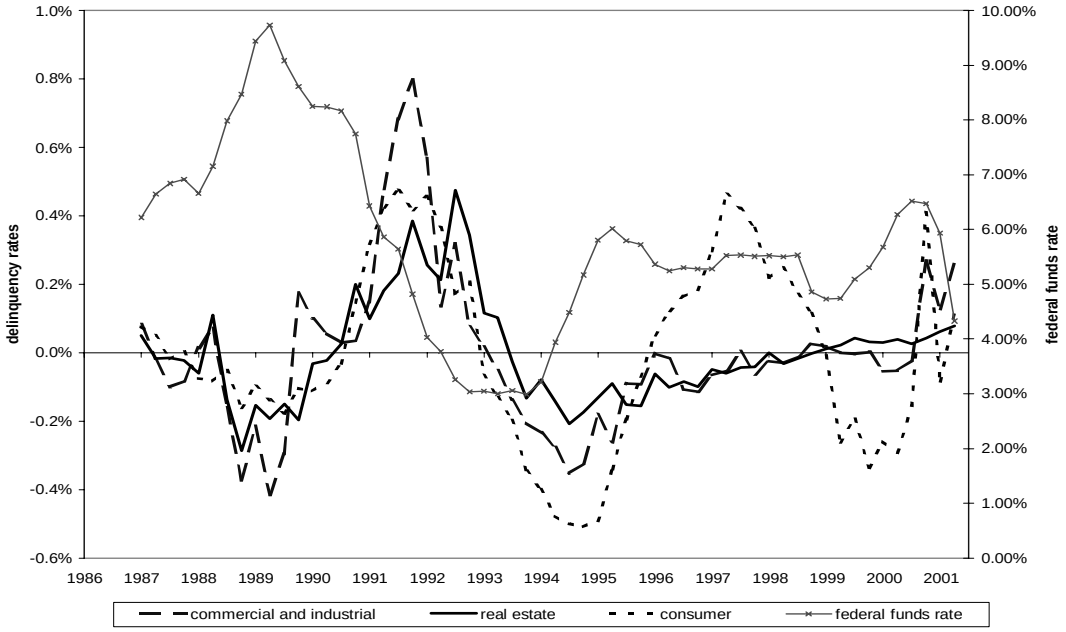

Note: This graphs plots the response of aggregate real income and commercial and industrial loans in response to a one-time negative one standard deviation shock in real income for a VAR specification with two lags and no trend.

Figure 12: Delinquency rates



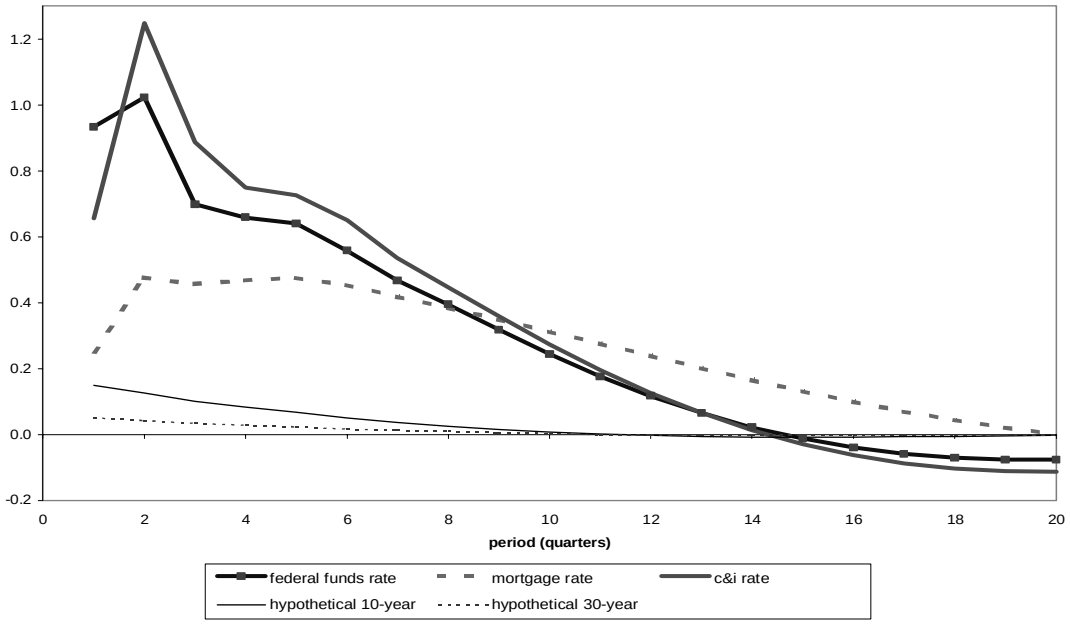

Note: This graph plots the federal funds rate and the HP-filtered delinquency rates for aggregate commercial and industrial loans, real estate loans and consumer loans for the period 1987:1-2001:2.

Figure 13: Charge-off Rates



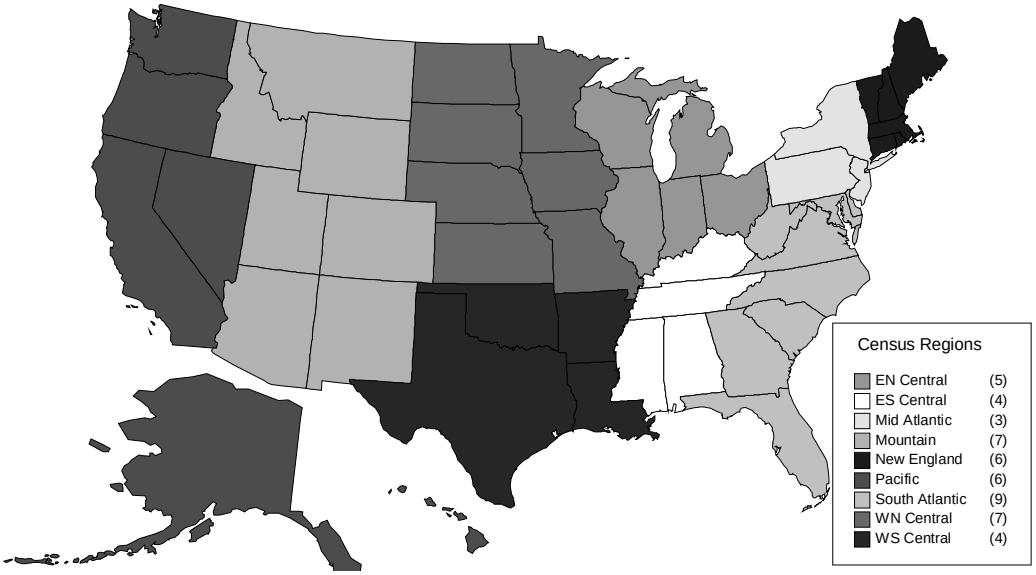

Note: This graph plots the federal funds rate and the HP-filtered charge-off rates for aggregate commercial and industrial loans, real estate loans and consumer loans for the period 1987:1-2001:2.

Figure 14: Interest Rates after a Monetary Tightening



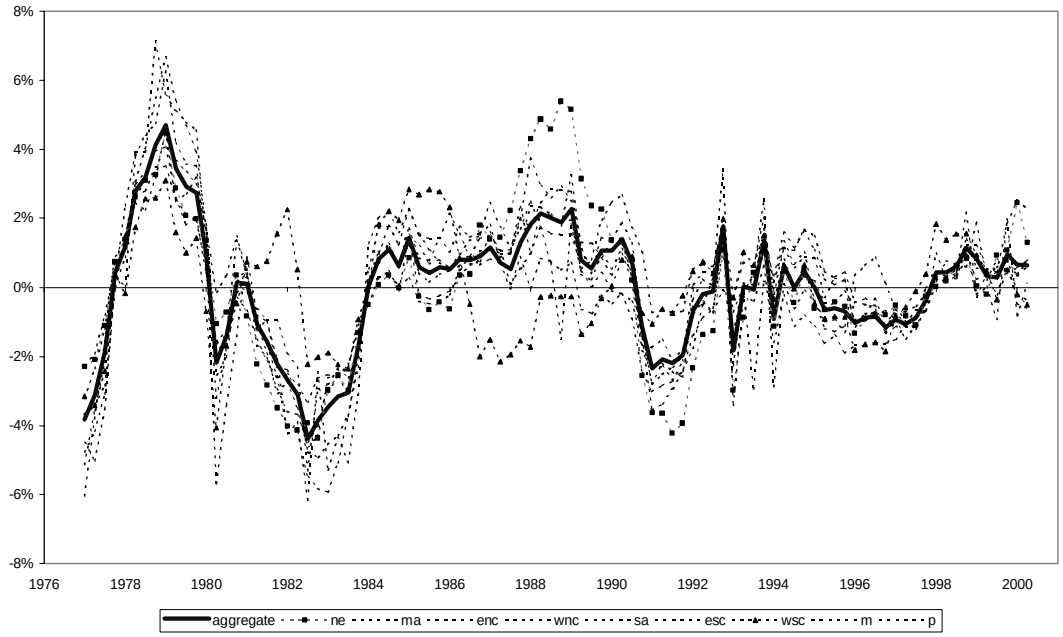

Note: This graph plots the impulse response function of the federal funds rate, the C&I loan rate, the rate on 30-year mortgages and the theoretical responses of the rate on a 10-year and 30-year debt instrument according to the expectations hypothesis. The estimated VAR contains 2 lags of each variable and no trend. The impulses are measured in percentage points on an annual basis.

Figure 15: Map of the Census Regions of the United States



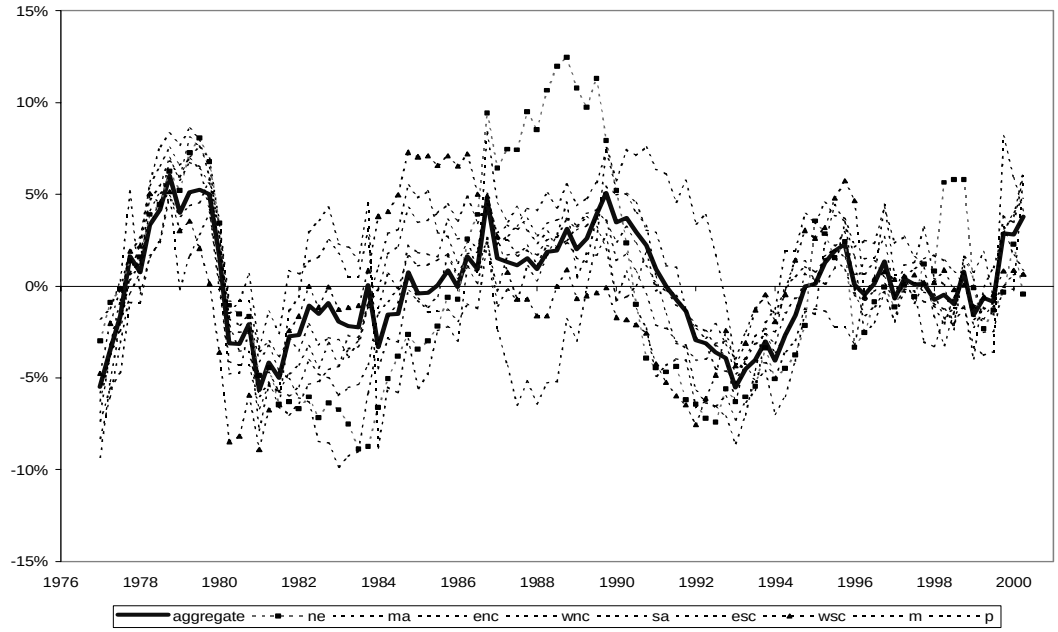

Note: This figure plots nine census regions: New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont), Middle Atlantic (New Jersey, New York and Pennsylvania, East North Central (Illinois, Indiana, Michigan, Ohio and Wisconsin), West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota), South Atlantic (District of Columbia, Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia), East South Central (Alabama, Kentucky, Mississippi and Tennessee), West South Central (Arkansas, Louisiana, Oklahoma and Texas), Mountain (Arizona, Colorado, Idaho, Montana, New Mexico, Utah and Wyoming) and Pacific (Alaska, California, Hawaii, Nevada, Oregon and Washington).

Figure 16: Deflated Aggregate and Census Region Earnings



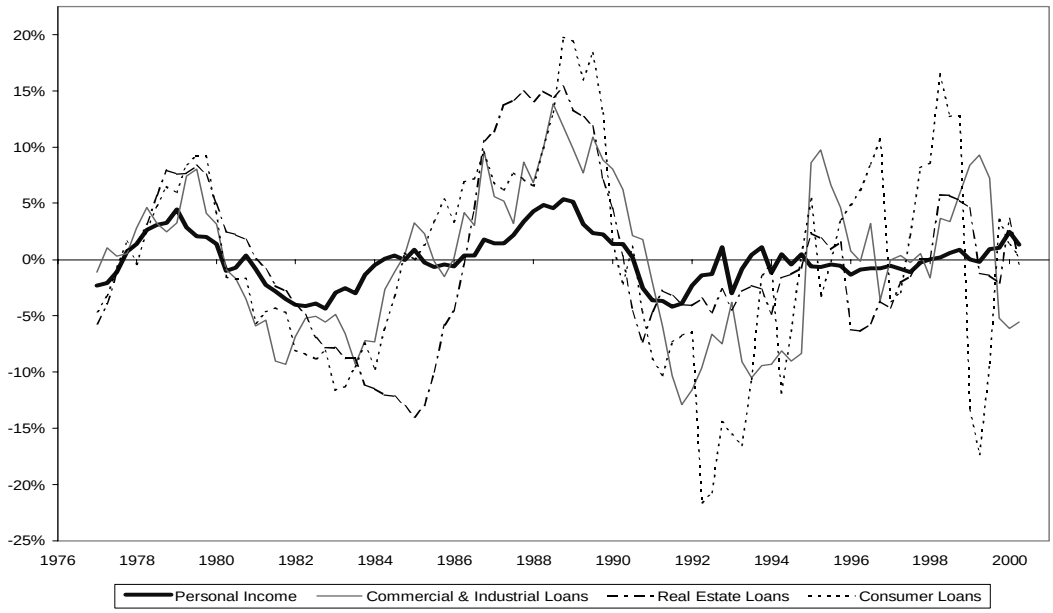

Note: This graph plots the percentage deviations from the trend of aggregate earnings and regional earnings when the HP filter is used to calculate the trend. All variables are deflated with the consumer price index.

Figure 17: Deflated Aggregate and Census Region Total Loans



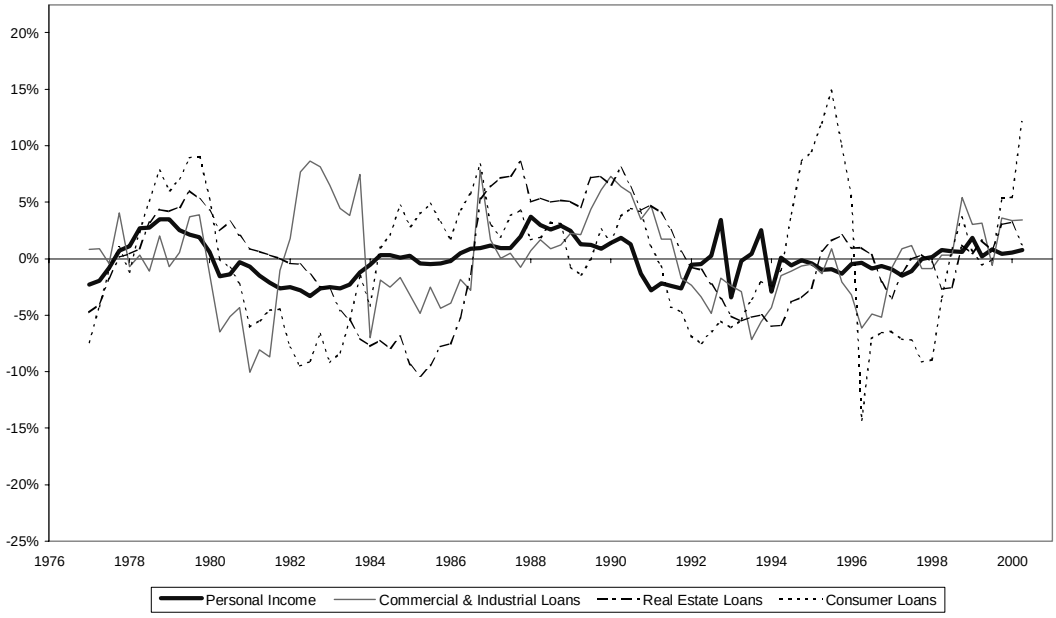

Note: This graph plots the percentage deviations from the trend of aggregate lending and regional lending when the HP filter is used to calculate the trend. All variables are deflated with the consumer price index.

Figure 18: Deflated Total Earnings and Loan Components in New England



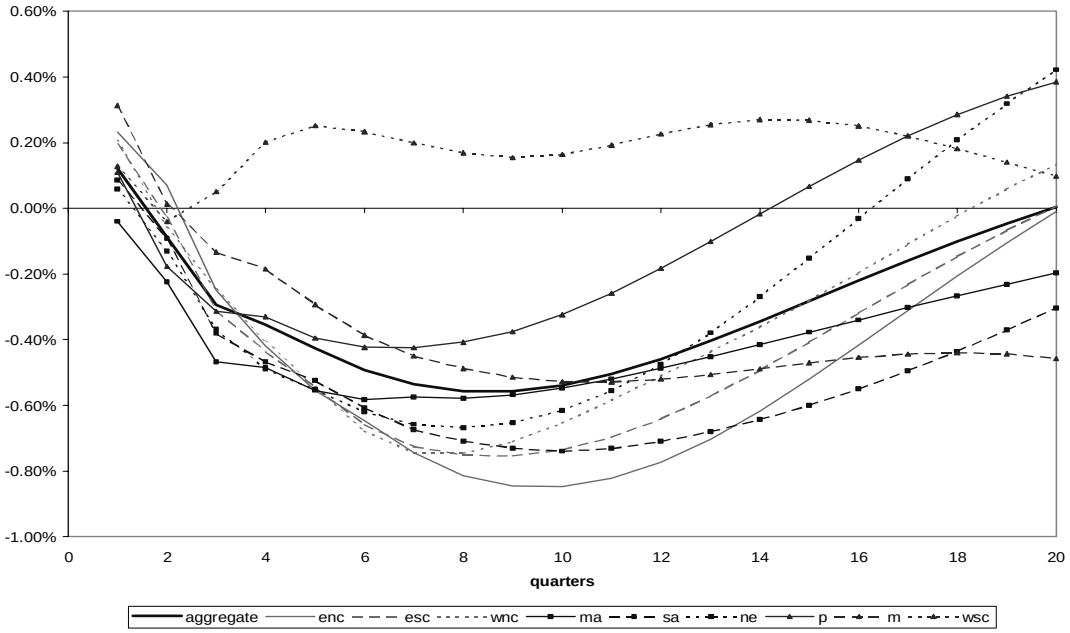

Note: This graph plots the percentage deviations from the trend of personal income and the lending components in New England when the HP filter is used to calculate the trend. All variables are deflated with the consumer price index.

Figure 19: Deflated Total Earnings and Loan Components in Mid Atlantic



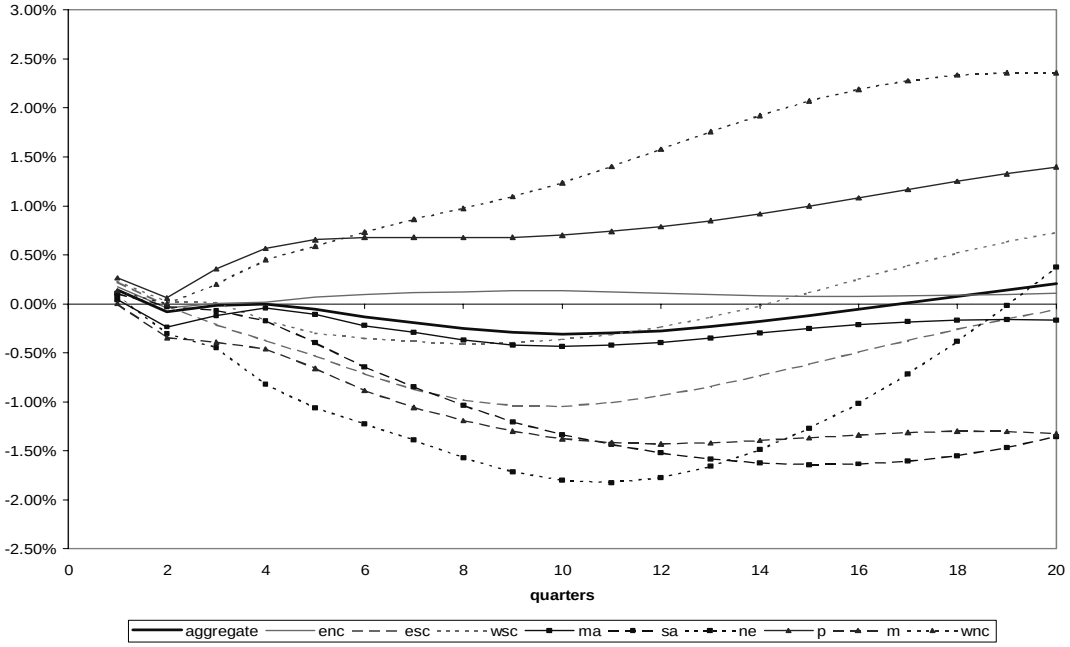

Note: This graph plots the percentage deviations from the trend of personal income and the lending components in the Mid Atlantic region when the HP filter is used to calculate the trend. All variables are deflated with the consumer price index.

Figure 20: Regional Income Responses after a (Negative) Monetary Policy Shock



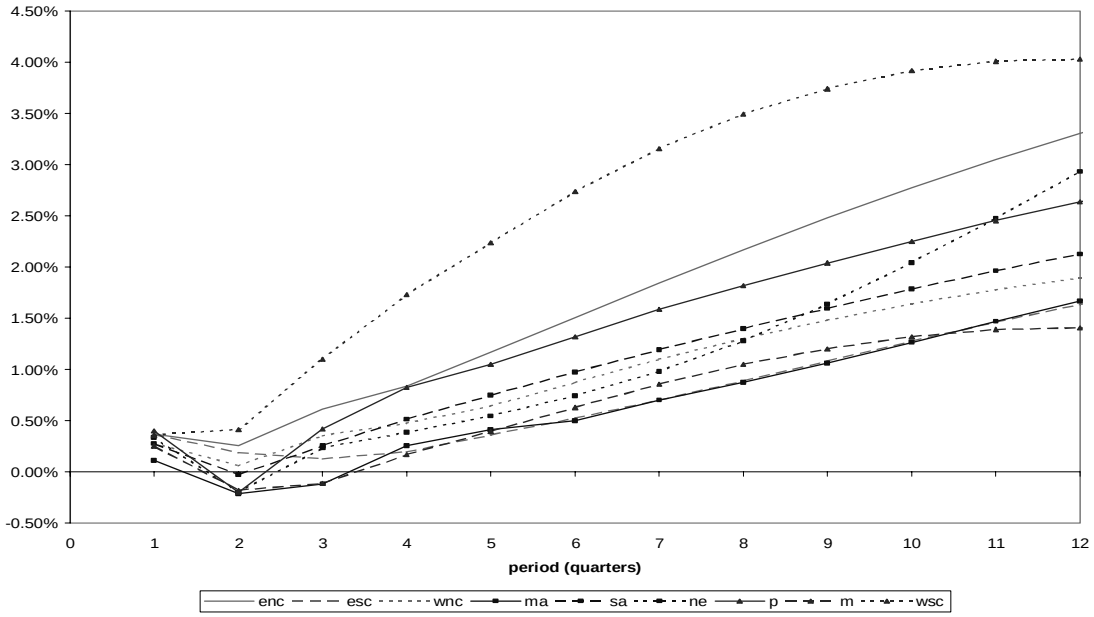

Note: This graph plots the impulse responses of regional and aggregate earnings in response to a one standard deviation shock to the innovation of the federal funds rate equation.

Figure 21: Regional Total Loan Responses after a (Negative) Monetary Policy Shock



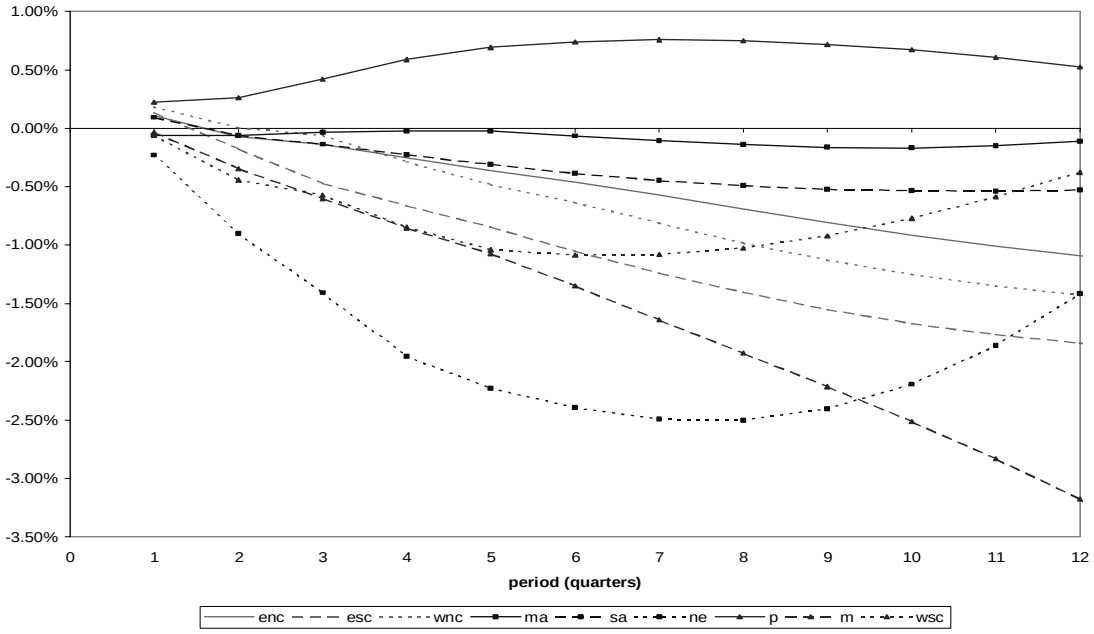

Note: This graph plots the impulse responses of regional and aggregate loans in response to a one standard deviation shock to the innovation of the federal funds rate equation.

Figure 22: Regional (Income-Corrected) C&I Loan Responses



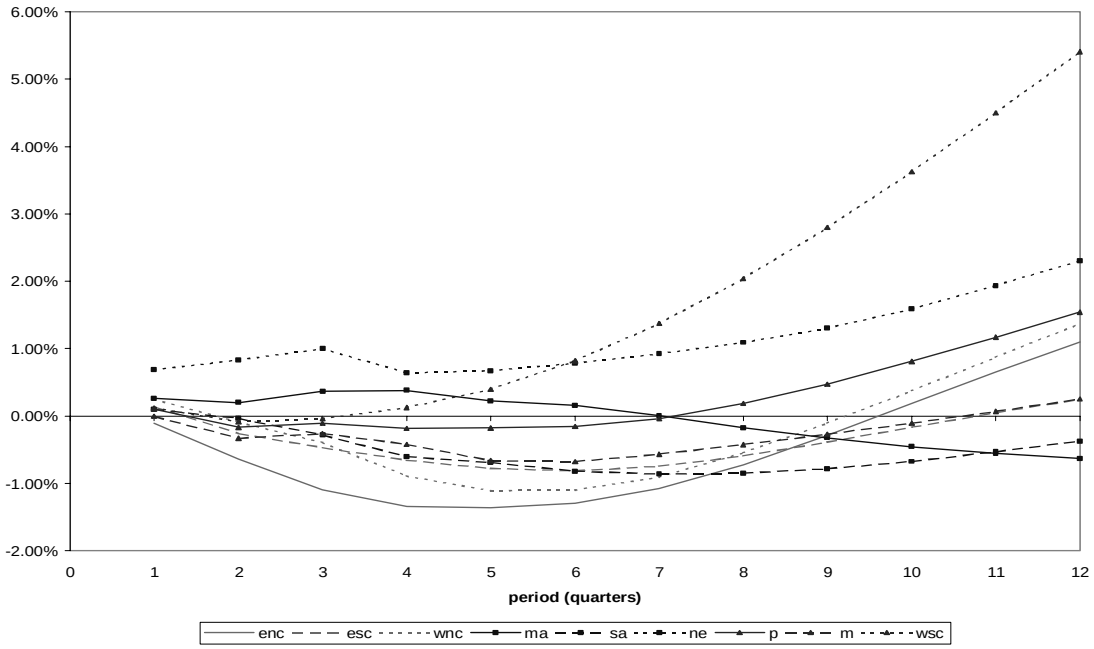

Note: This graph plots the income-corrected impulse response function of aggregate and regional commercial and industrial loans in response to a one standard deviation shock to the innovation of the federal funds rate equation.

Figure 23: Regional (Income-Corrected) Real Estate Loan Responses



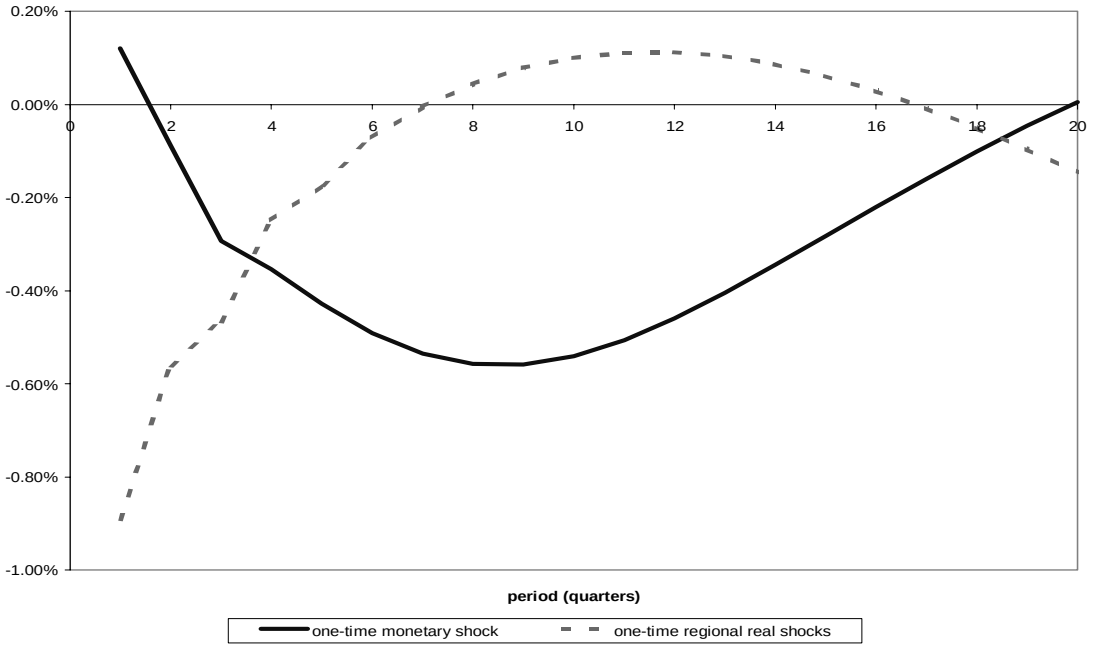

Note: This graph plots the income-corrected impulse response function of aggregate and regional real estate loans in response to a one standard deviation shock to the innovation of the federal funds rate equation.

Figure 24: Regional (Income-Corrected) Consumer Loan Responses



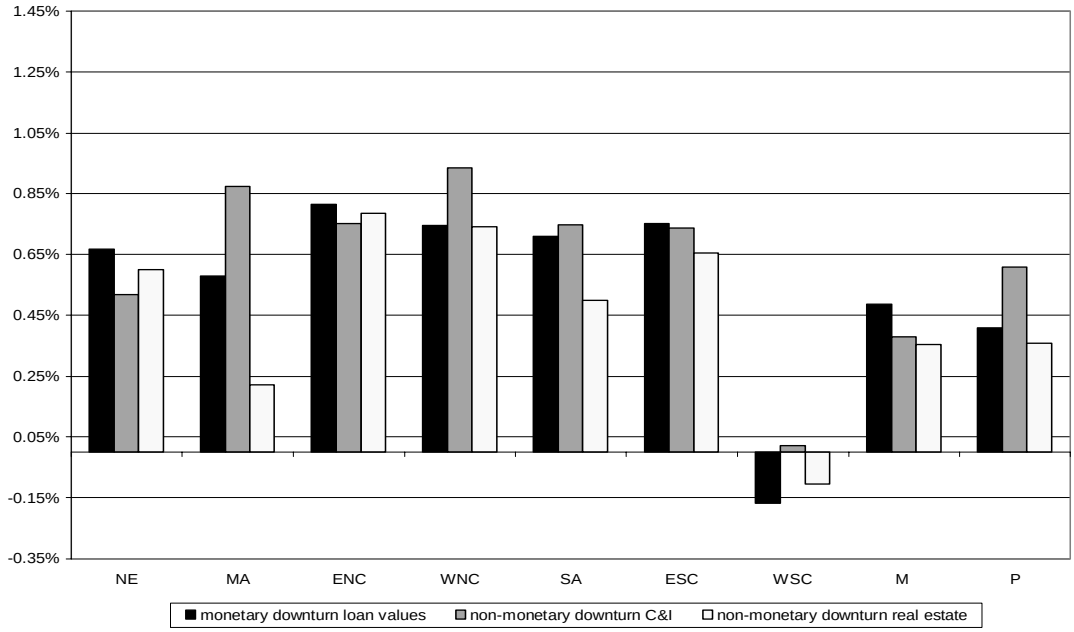

Note: This graph plots the income-corrected impulse response function of aggregate and regional consumer loans in response to a one standard deviation shock to the innovation of the federal funds rate equation.

Figure 25: Income Responses to One-Time Monetary and Non-Monetary Shocks




Note: This graphs plots the response of aggregate real income in response to either a one-time positive one standard deviation shock in the federal funds rate or a one-time negative one standard deviation shock to real income in each of the nine census regions.

Figure 26: Importance of Commercial and Industrial Loans and Real Estate Loans




Note: This graph plots the two-year cumulative income response when loan responses are equal to the typical values after a monetary downturn and when the indicated loan component has the responses that are observed during a non-monetary downturn

Figure 27: Supply and Demand Interpretation

A: Supply

monetary tightening $\Rightarrow$ (income-corrected) C&I loans $\uparrow$ $\Rightarrow$ drop in income is dampened

$\uparrow$

This effect stronger for small banks

B: Demand

$\Rightarrow$ income drops

monetary tightening $\Rightarrow$ interest rates $\uparrow$ $\not\Downarrow$

$\Rightarrow$ demand for commercial and industrial loans $\downarrow$

$\uparrow$

there is a positive cross-sectional
correlation because some state characteristics
make both these affects stronger