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Abstract

In this paper, we analyze the business cycle behavior of home mortgages and consumer credit and investigate whether the observed changes—and in particular observed changes in the comovement between the loan variables and real activity—are likely to be caused by changes in financial markets. We find that there may have been such a role for changes in markets for consumer credit, but even before the financial crisis hit, the data do not support the hypothesis that changes in mortgage markets reduced the impact of economic shocks on real activity.

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1 Introduction

In this paper, we analyze the time series properties of key real activity variables as well as household loan variables and try to detect evidence for the hypothesis that changes in financial markets are responsible for changes in the properties of the US business cycle before the financial crisis hit and if so in what way. One well-known change is that the positive comovement between household loans and GDP has basically disappeared. This change has been interpreted as evidence that financial innovation has had an impact on business cycle properties and in particular that it is one of the driving forces behind the great moderation.1 The idea is that financial innovation made it possible to keep on lending during economic downturns, which reduced the magnitude of fluctuations in GDP.

A sharp reduction in the comovement between loans and real activity, however, is also consistent with the hypothesis that financial innovation had no impact on the way loans and real activity responds to shocks and that the drop in the comovement is due, for example, to a drop in the importance of those shocks that lead to a positive comovement. We use VARs, estimated over an early and later sample, and investigate whether the impulse response functions (IRFs), i.e., the responses of key macro variables to shocks, have changed over time. The IRFs provide much more information than the unconditional correlation statistics typically used to characterize the comovement between loans and real activity; not only do they condition on the shock, they also provide information about the dynamic aspects of the comovement. The empirical analysis makes it possible to answer (i) the question which IRFs have changed and which have not and (ii) the question whether the reduction in the comovement is simply due to some shocks becoming less important.

Moreover, the detailed information provided by the VAR makes it easier to answer the question whether the changes in the IRFs that did occur are likely to be due to financial innovation or not. We divide the observed changes in the following two categories. The first type of change is hard to reconcile with financial innovation. The second type is consistent with financial innovation, but also consistent with other explanations.2

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1 See, for example, Campbell and Hercowitz (2006) and Iacoviello and Pavan (2008).

2 We do not think that there are changes that can only be explained by financial innovation. Of course,
We argue that there is much more convincing empirical evidence that financial innovation changed the cyclical behavior of consumer credit than home mortgages. The reasons are the following. First, the IRFs related to consumer credit are subject to large changes, whereas those for home mortgages are not. Second, the changes related to home mortgages are difficult to reconcile with standard theories about the effects of financial innovation. The fact that the responsiveness of home mortgages to shocks did not change that much, and clearly not as much as the responsiveness of consumer credit, suggests that the observed financial hubris had not substantially improved the ability of mortgage markets to accommodate shocks to the economic system. Perhaps this should have been a warning sign.

2 Data & Methodology

2.1 Data

Our data for home mortgages and consumer credit are from the Flow of Funds data set and cover the sample from 1953Q3 to 2008Q1. For the household sector, home mortgages and consumer credit are the two largest liabilities. For example, in 2005, home mortgages were 72% of total liabilities and consumer credit was 18%. Home mortgages not only include first and second mortgages on one-to-four-family properties, but also loans taken out under home equity lines of credit. There are many different types of consumer credit. Two particularly important categories are revolving credit (credit cards) and nonrevolving credit (e.g., automobile loans).\(^3\)

In this paper, we focus on household liabilities independent of ownership of the associated asset. The fraction of loans owned by banks has become smaller over time; even when loans are initiated by banks, they often end up on the balance sheet of other (financial) institutions. Important for the increased incidence of ownership transition (both between different types of financial institutions and between banks) has been the emergence of alternative explanations may not be equally plausible.

\(^3\)Of the $2.3 trillion in consumer credit outstanding at the end of 2005, $850 billion was in the form of revolving credit and $1.4 trillion in the form of nonrevolving loans.
"special-purpose vehicles". In 2005, $614 billion of the $2.1 trillion in consumer credit was held in pools of securitized assets. The securities issued to finance the purchase of these pools may be held by banks or other institutions, but for the analysis performed here we do not distinguish between the ownership of the liability. In ongoing research, we investigate whether the cyclical properties of the loans owned by different entities differ and whether this has played a role in the changing time series behavior of the total. Here, however, we are interested in how the business cycle behavior of the total amount of mortgages and consumer credit available to households has changed.

2.2 Identifying monetary shocks

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

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

(1)

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

\[ u_t = \overline{A} \varepsilon_t, \]  

(2)

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

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4To simplify the notation, we do not display the constant and the linear trend term that are also included. As a robustness check, we used data that are detrended using one trend specification for the complete sample. This leads to very similar results. The results are also robust to using a quadratic trend.
\[ E[u_t' u_t] = \bar{A} \bar{A}'. \]  

When \( E[u_t' u_t] \) is replaced by its sample analogue, one obtains \( k(k+1)/2 \) conditions on the coefficients in \( \bar{A} \). Since \( \bar{A} \) has \( k^2 \) elements, \( k(k-1)/2 \) additional restrictions are needed to estimate all elements of \( \bar{A} \). A standard practice is to obtain the additional \( k(k-1)/2 \) restrictions by assuming that \( \bar{A} \) is a lower-triangular matrix. Christiano, Eichenbaum, and Evans (1999), however, show that to determine the effects of a monetary policy shock one can work with the less-restrictive assumption that \( \bar{A} \) has the following block-triangular structure:

\[
\bar{A} = \begin{bmatrix}
\bar{A}_{11} & 0_{k_1 \times 1} & 0_{k_1 \times k_2} \\
\bar{A}_{21} & \bar{A}_{22} & 0_{1 \times k_2} \\
\bar{A}_{31} & \bar{A}_{32} & \bar{A}_{33}
\end{bmatrix}
\]

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

We follow Bernanke and Blinder (1992) and many others by assuming that the federal funds rate is the relevant monetary instrument and that innovations in the federal funds rate represent innovations in monetary policy. Our benchmark specification is based on the assumption that \( X_{2t} \) is empty and that all other elements are, thus, in \( X_{1t} \). Intuitively, \( X_{2t} \) being empty means that the Board of Governors of the Federal Reserve (FED) can respond to contemporaneous innovations in any of the variables of the system. For quarterly data, an identification based on the exclusion of contemporaneous effects seems plausible.

### 2.3 Comovement decomposition

In this paper, we also use the comovement statistics of den Haan (2000) to characterize the correlation of different variables. An advantage of this procedure is that it captures the dynamic aspects of the comovement. In addition, it is straightforward to determine
which shock is responsible for which fraction of the total correlation coefficient.

In particular, den Haan (2000) shows that the covariance between the $K$th-period ahead forecast errors of $x_t$ and $y_t$, $COV(x; y; K)$, is equal to

$$COV(x, y; K) = \sum_{m=1}^{M} COV(x, y; K, m)$$

with

$$COV(x, y; K, m) = \sum_{k=1}^{K} x_{imp,m}^{k}; y_{imp,m}^{k},$$

where $x_{imp,m}^{k}$ ($y_{imp,m}^{k}$) is the $k$th-period responses of variable $x$ ($y$) to a one-standard-deviation innovation of the $m$th shock. The cross product $x_{imp,m}^{k}; y_{imp,m}^{k}$ indicates whether variables $x$ and $y$ move in the same or in opposite direction after an innovation in the $m$th shock.\(^5\) The total covariance is simply the accumulated sum of the cross products for all possible shocks. There are seven variables in our VAR, so there are also seven shocks, that is, $M = 7$. To decompose the correlation coefficient, we use

$$COR(x, y; K) = \sum_{m=1}^{M} COR(x, y; K, m)$$

with

$$COR(x, y; K, m) = \frac{\sum_{k=1}^{K} x_{imp,m}^{k}; y_{imp,m}^{k}}{SD(x; K)SD(y; K)};$$

$$SD(z; K) = \left(\sum_{m=1}^{M} COV(z, z; K, m)\right)^{1/2}$$

for $z = x, y$.

We use the total standard deviations in the denominator to ensure that the sum of all the scaled covariances is equal to the total correlation coefficient.

### 3 Summary statistics

In this section, we discuss trends in consumer credit and home mortgages and standard business cycle statistics over the period from 1953Q3 to 2008Q1.

**Trends.** Panel A of Figure 1 documents how the two loan components have grown as a fraction of GDP. Both liabilities have increased as a fraction of GDP, but home mortgages have increased at a much sharper rate. Consumer credit increased from 9.3% of GDP in 1955Q1 to 18.2% of GDP in 2007Q4, whereas over the same period home mortgages

\(^5\)Identification assumptions affect the impulse response functions, and thus, the decomposition of the covariance, but not the total magnitude.
increased from 19.5% of GDP to 75.0%. The observed increases do not necessarily imply that consumers borrow more relative to the value of their total housing stock or stock of durables. It may also be the case that the value of durables and real estate has increased faster than GDP or that the amount of durables and housing relative to GDP has increased. Panel B of Figure 1 plots the two liabilities scaled by the value of the associated asset. Scaled by the value of real estate, home mortgages increased from 20.4% in 1955Q1 to 47.1% in 2007Q4. This is clearly not as sharp as the increase of mortgages relative to GDP, but still quite impressive. As a fraction of durables, consumer credit doubles, namely from 28.9% to 63.4%, just like it did as a fraction of GDP.

The increases in home mortgages and consumer credit have not been uniform over the sample period. Let’s first consider home mortgages. As a fraction of GDP, home mortgages have displayed quite an intriguing growth process. There are several periods in which the growth rate of home mortgages as a fraction of GDP sharply increases, but the sustained increase in the growth rate of home mortgages relative to GDP that started around the beginning of the new millennium is without precedent. As a fraction of real estate, however, the growth pattern is a bit simpler and very similar to the pattern observed for consumer credit. That is, a sharp increase in the fifties and early sixties followed by a period of no growth, and finally a renewed steady increase. Interestingly, using real estate as the scaling’s factor, there is no sharp acceleration at the end of the sample. The recent acceleration of home mortgages relative to GDP can, thus, for a large part be attributed to an acceleration of the value of the stock of housing relative to GDP.

Now consider consumer credit. As a fraction of GDP, consumer credit has displayed only a slow steady increase. As a fraction of durables, a different picture emerges. A large part of the growth is located in the beginning of the sample. Consumer credit increased to 41.9% of durables in 1970 and was then remarkably stable for over two decades. Starting in the early nineties, the ratio started to increase again.

**Cyclical behavior.** In Figure 2, we plot the cyclical components of the two loan variables, residential investment, and durable purchases. It also plots the nominal interest rate and the cyclical component of GDP. Table 1 reports the standard deviations of the
cyclical components and table 2 the cross correlations.

In addition, we report the comovement statistics proposed in den Haan (2000). These provide an alternative way to describe the comovement between two series. This procedure uses an estimated VAR to calculate the implied correlation between the forecast errors of two series at different forecast horizons. By looking at different forecast horizons one obtains a more complete picture of the comovement, including the dynamic aspects of the comovement. The dynamic aspects are also a feature of impulse response functions (IRFs), but the disadvantage of impulse response functions is that they require identifying assumptions. Figures 3 and 4 plot the statistics for home mortgages and consumer credit, respectively. Panel A of each figure plots the correlation with GDP and panel B the correlation with the associated spending component.

The following observations can be made.

- **Volatility of real activity.** Table 1 confirms the well-known result that the volatility of cyclical movements in GDP is much smaller in the second subsample than in the first subsample. The volatilities of residential investment and durable expenditures display a drop of almost the same size. Figure 2 indicates that the incidence of large swings in the cyclical component of GDP has been reduced in the later sample (fewer recessions) and the magnitude of the fluctuations has become smaller. This is also true for residential investment and durables, although both spending components decreased sharply during the recession of the early nineties. Moreover, residential investment also seems to have started a sharp decrease during the recent financial crisis.

- **Volatility of loan variables.** The reduction in the volatility of the cyclical component of home mortgages and durable expenditures is much smaller. The standard deviation of home mortgages in the 1984:1-2008:1 sample is only 19% below the standard deviation in the 1954:3-1978:4 sample and the reduction is 21% for consumer credit. The figure suggests that the use of the HP filter to construct the cyclical components may have underestimated the reduction in volatility for home mortgages. In the later sample, the cyclical component of home mortgages starts
out being positive and then gradually decreases until it becomes negative. If this gradual reduction would have been filtered out, then the standard deviation of home mortgages would have fallen by more.

- **Comovement between GDP and loan variables.** Figure 2 and table 2 document another difference between the earlier and the later sample that is at least as striking as the reduction in volatilities. That is, the sharp reduction in the correlation between the cyclical component of GDP and the cyclical components of the two loan categories. The correlation between home mortgages with GDP drops from 0.81 to 0.05 and the correlation between consumer credit and GDP drops from 0.74 to 0.18. The change in the pattern of comovement is also clearly visible in Figure 2. In the beginning of the sample, there is a very close connection between the movements of the cyclical component of GDP and the two loan categories, a link that seems to have virtually disappeared in the later half of the sample. In particular, home mortgages do not drop during the recession of the early nineties, whereas residential investment as well as consumer credit and durables do display a substantial decline. Most interestingly, consumer credit seems to move in an opposite direction to both GDP and durable expenditures since the mid nineties. Figures 3 and 4, that plot the correlation coefficients of the VAR forecast errors, also document a substantial drop in comovement. The drop in the positive correlation between consumer loans and GDP is—as argued by Campbell and Hercowitz (2006)—consistent with the hypothesis that financial innovations make it easier for consumers to keep on lending during an economic downturn. Of course, it is also possible that the correlation has changed for reasons that are not related to financial innovation. An alternative explanation is that the comovement differs for different underlying shocks and that shocks that cause a positive comovement have become relatively less important.

- **Comovement expenditure components and loan variables.** We also find a drop in the comovement between the cyclical components of durable expenditures and consumer credit, although the drop is not as large as the drop for the correlation with GDP. When we look at the correlation of home mortgages and residential
investment, then we basically find no drop in the correlation coefficient when it is constructed using VAR forecast errors and only a relatively small drop when we look at the correlation of HP-filtered series.

- **Comovement loan variables.** The correlation between the two loan variables has decreased drastically. As documented in table 2, it was equal to 0.92 in the early subsample, while it was only 0.11 in the later subsample. Figure 2.B documents that since the mid nineties the cyclical components of consumer loans and GDP seem to move in opposite directions, a pattern clearly not observed for home mortgages and GDP.

The reduction in the correlation between GDP and loan variables has received attention in several papers and we will delve deeper into possible reasons behind the drop throughout this paper. The results in table 2 suggest that there are two aspects to the drop in this correlation between the loan components and GDP. First, there is a drop in the correlation between the loan components and the associated spending component. This drop is clearly not as spectacular as the drop in the correlation with GDP. For example, the correlation between consumer credit and durable expenditures drops from 0.64 to 0.31 and the correlation between home mortgages and residential investment drops from 0.48 to 0.32. So although there is a considerable drop, there still is a substantial amount of correlation left. The other part of the story seems to be that the correlation between GDP and the spending components has dropped. The correlation between residential investment and GDP has dropped from 0.59 to 0.48 and the correlation between durable expenditures and GDP has dropped from 0.87 to 0.63.

Below we will argue that the behavior of consumer credit has changed much more than that of home mortgages and that the observed changes are more consistent with financial innovation for consumer credit than for home mortgages. There is little support for that claim in the results reported here. In fact, the drop in the correlation between GDP and mortgages is larger than the drop in the correlation between GDP and consumer credit. In the next section, we will show that if one conditions on the type of shock that the behavior of home mortgages has remained fairly constant, while that of consumer
credit has not. But a careful look at the results reported here already shows that there are important differences between consumer credit and home mortgages. First, Figure 2 shows that starting in the mid nineties consumer credit has become basically countercyclical. A careful look at the graph for home mortgages raises the question whether the drop in the unconditional correlation is not in part driven by a phase shift, that is, a change in the lead-lag structure.

4 Impulse response functions

We divide the discussion of the IRFs into two parts. In Section 4.1, we discuss the IRFs of a monetary shock. In Section 4.2, we discuss the IRFs of the remaining shocks. The key difference is that the monetary policy shocks have a (more) structural interpretation and there is a measure for the size of the underlying shock, namely the change in the federal funds rate. The first subsample considered covers again the period from 1953Q3 to 1978Q4 and the second subsample covers the period from 1984Q1 to 2008Q1.\(^6\)

4.1 Monetary tightening

In the early subsample, all three real activity measures, GDP, residential investment, and durable expenditures, as well as the two loan variables, home mortgages and consumer credit, display a sizable and significant decrease following a monetary tightening. Results are quite different in the later subsample. There is no longer a reduction in GDP and durable expenditures, which is consistent with the results reported in Boivin and Giannoni (2002, 2006).\(^7\) The response of residential investment has become smaller, but is still significantly negative. The response has become much more delayed and more persistent. This pattern for the response of residential investment is also found by McCarthy and Peach (2002). The maximum drop in residential investment (during the first five years)

\(^6\)We get almost identical results for the first subsample if the first subsample continues to 1983Q4.
\(^7\)For this specification of the VAR, we actually find a small marginally significant increase in GDP. This increase is, however, not robust. It is possible to get a small significant decline, but only for a few VAR specifications. Boivin and Giannoni (2006) also report IRFs with positive and negative responses for GDP.
is equal to 2.7% in the early subsample and only 1.1% in the later subsample. But the maximum increase in the federal funds rate has also dropped, namely from 76.8 to 32.2 basis points.

A very robust finding is that the negative responses of consumer credit and durable expenditures have disappeared. The possible link between these two changes and the possible role of financial innovation in explaining this will be discussed in Section 5. The maximum decrease in home mortgages (during the first five years) dropped from 0.71% to 0.29%, but relative to the size of the federal funds rate response this is only a minor reduction. Moreover, since home mortgages have increased sharply relative to GDP, the same percentage decrease in home mortgages implies a much larger change in the amount of home mortgages relative to GDP. For all VAR specifications considered, we find a sizable reduction in home mortgages. In fact, with several VAR specifications we find reductions in home mortgages that are close in magnitude to the responses found in the first subsample, even though the increase in the federal funds rate is always substantially smaller.

In the early sample, the IRF of prices suffers from the price puzzle in that there is a significant increase during the first two years. In the second subsample, there is a small and quite rapid reduction in the price level. Over the whole sample, there is virtually no price puzzle and prices almost follow the textbook response, that is, flat initially and then a reduction.

4.2 Other shocks

There are seven variables in our VAR and one could in principle identify six more shocks. We use the Cholesky decomposition and ordered the remaining variables so that those variables that are likely to have the slowest response are ordered first.\(^8\) Although this is not an implausible assumption, one could clearly question whether the identified shocks are truly structural. For our purpose this is not strictly necessary. We show that several

\(^8\)The ordering of the variables is as follows: price level, residential investment, durable expenditures, GDP, home mortgages, consumer credit, and federal funds rate.
aspects of the driving process, as represented by the IRFs of the VAR, have remained quite stable over time. The fact that there is little change in the estimated IRFs is remarkable, independent of whether the shocks have a structural interpretation or not.

**Real activity shock**  The three real activity variables are GDP, durable expenditures, and residential investment. The IRFs of the three corresponding shocks have several similarities. For example, all three lead to a reduction in GDP and lead to—as predicted by the Taylor rule—a reduction in the federal funds rate. Residential investment and durable expenditures, however, do not always move in the same direction, which means that part of these shocks are related to shocks that result in some reallocation. To streamline the discussion, we focus on the IRFs that corresponds to the responses when the innovation of each of the three variables is equal to 1 standard deviation. In the appendix, we give the IRFs of the three separate shock and show that the main conclusions of this subsection do not depend on looking at the joint shocks.

In both subsamples, the initial downturn in each of three real activity variables is followed by an upturn. This upturn is quite substantial for residential investment. The federal funds rate drops and more so in the second subsample, even though the economic downturn is less severe. Prices drop in both subsamples. The IRF of home mortgages is similar to the IRF of residential investment, but the initial downturn is much smaller. If there is a difference in the IRF of home mortgages across the two samples, then it is that the IRF turns positive sooner.

For consumer credit we find that the qualitative shape of the IRFs is similar in the two subsamples, but that the magnitude of the drop and the significance levels have become smaller. The drop in magnitude resembles the drop in magnitude of the responses of the real activity variables. As documented in the appendix, the responses of consumer credit to a "GDP shock" and a "durable expenditure" shock have not changed, but the response of consumer credit to a "residential investment shock" has disappeared.

As explained below, the responses to a monetary tightening and a real activity shock turn out to be the relevant ones for our analysis. For completeness, we also discuss the IRFs of the remaining shocks.
**Consumer credit shock.** Almost none of the responses to a consumer credit shock, except those of consumer credit itself, are significant. Interestingly, the IRFs of both durables expenditures and GDP have the same shape in both subsamples, namely initially negative, then positive, and then negative. The difference between the two subsamples is that the second set of negative IRF values occurs earlier in the first subsample and is larger even though the credit response is less negative.

**Home mortgage shock.** Like consumer credit shocks, home mortgage shocks are not associated with many significant real activity responses. A notable exception is found in the second subsample when a home mortgage shock leads to a significant and more persistent (but not larger) decline in residential investment. The responses of home mortgages themselves have become larger in the second period.

**Prices.** The price shock does not generate many significant values for the IRFs; the IRF of durable expenditures in the second subsample is the only IRF for which there are several substantial responses. If anything, a positive increase in prices is associated with a reduction in real activity. When we ignore that most responses are not significant, then we can make the following observations when we compare the two subsamples. First, the federal funds rate displays a (marginally significant) positive response to the increase in prices in the second subsample, but not in the first. Second, the responses of GDP have become smaller and those of residential investment and durable expenditures larger (in absolute values). Third, loan responses have become more negative and for home mortgages the insignificant positive responses beyond the sixth period have all turned negative, some of them even significantly so.

## 5 Financial innovation

It is not unusual in empirical work that the IRFs of VARs are not very robust in the sense that minor changes in the specification lead to different outcomes. We find it, therefore, surprising that there are in fact quite a few patterns that have remained stable over time,
even though there have been many changes in, for example, financial markets and the way monetary policy is conducted. But there also have been several IRFs that did change considerably. The question we address in this section is whether these changes could be the result of financial innovation. In Section 5.1, we discuss what kind of patterns are consistent with standard views of financial innovation, what kind of patterns are strongly suggestive of financial innovation, and what kind of patterns are not very likely the result of financial innovation. In Section 5.2, we then relate this discussion to the changes observed for our estimated IRFs.

5.1 Changes in business cycle behavior and financial innovation

That financial markets have changed considerably is beyond dispute. It is not clear, however, whether financial innovation has changed the business cycle properties of the US economy. Theory does not provide us with an unambiguous prediction about the effects of financial innovation on business cycle properties. One possibility is that the volatility of economic variables becomes smaller, for example, because better diversification of financial institutions makes it easier for them to keep on lending during economic downturns, which in turn dampens the reduction in loans and the corresponding spending components. It is also possible, however, that financial innovation increases the responsiveness to (some) shocks. The reasoning is as follows. Financial innovation has clearly increased the total amount of household debt relative to income and asset values. But if financial institutions lend out more and in particular lend out more to riskier borrowers, then it may very well be the case that this additional debt puts a higher burden on borrowers during economic downturns, which in turn leads to sharp reductions in the supply of debt during economic downturns. Thus, both an increase and a reduction in the response to a shock could be consistent with financial innovation.

Financial innovation has not been the only important structural change that took place in the post-war period. For example, monetary policy has changed a lot, services have grown sharply relative to manufacturing, and there have been changes in product market competition and inventory control. The question arises whether there are partic-
ular changes that are typical for financial innovation and are more difficult to reconcile with other important changes and whether there are particular changes that are hard to reconcile with financial innovation. Suppose that following a monetary tightening (\(i\)) the response of loans to a particular shock is significantly negative in the first subsample, (\(ii\)) this response is significantly positive in the second subsample, and (\(iii\)) the decline in output has become smaller. This set of changes seems to us highly suggestive that the changes are due to financial innovation.\(^9\) On the other hand, if the response of loans becomes more negative and the response of output less negative, then this suggests quite strongly that financial innovation cannot have been a major factor behind these changes or is at least dominated by other changes.

In the remainder of the section, we will go through the differences between the two subsamples discussed above and try to tell stories. That is, we will see whether the observed changes can be easily, or perhaps even exclusively, explained with standard theories about financial innovation. The results can be summarized as follows. First, although there clearly are changes in business cycle behavior that are consistent with financial innovation, none cleanly fit the pattern described above. Second, when we compare the results for consumer credit and home mortgages, then the changes observed for consumer credit are consistently more in line with the hypothesis that financial innovation in consumer credit has had an impact on the cyclical behavior of consumer credit and the volatility of real activity, than the hypothesis that financial innovation in home mortgages has had such an impact.

\(^9\)For every pattern, there is probably more than one story to tell. For example, this pattern would be consistent with a world in which there is no financial innovation, but in which (\(i\)) loan supply increases following a monetary tightening, (\(ii\)) loan demand decreases if real activity decreases, and (\(iii\)) real activity decreases by less in the second subsample for reasons not related to financial innovation, e.g., because of more flexible prices. If the demand effect is less in the second subsample, then it could be dominated by the (unchanged) supply effect and we would observe a change in the sign of the loan response together with a smaller real activity response.
5.2 Are observed changes in business cycles due to financial innovation?

In Sections 3 and 4, we documented that the values of several standard deviations and correlation coefficients as well as IRFs had changed over time. We now address the question whether these changes are (most) consistent with financial innovation or whether the observed changes are hard to reconcile with financial innovation. In particular, is it reasonable to conclude that financial innovation is an important factor behind the reduction in the volatility of real activity and the reduction in the covariance between loans and GDP?

5.2.1 Financial innovation and changes in monetary IRFs

The IRFs corresponding to a monetary policy shock have an important advantage that the other IRFs do not have and that is that the instantaneous response of the federal funds rate can be taken as a reasonable measure of the size of the shock. That is, a larger unexpected change in the federal funds rate corresponds with a larger underlying structural shock. For the other shocks this is not so clear cut, because the first-period responses provide not only a measure of the magnitude of the underlying structural shock, but also of the magnitude of the instantaneous response.

1. **Home mortgages:** Monetary policy shocks are definitely smaller in the second subsample, but they are also more persistent, that is, the federal funds rate takes longer to return to its pre-shock value. To facilitate the comparison of the responses in the face of these different time paths of the federal funds rate, we plot in Figure 10 the IRF of home mortgages and residential investment for the VAR of the second subsample when we feed the VAR a series of monetary policy shocks that result in an IRF for the federal funds rate that is identical to the one observed in the first subsample. The figure also plots the IRFs of these two variables for the first subsample. The figure documents that the responses of residential investment are not smaller in the later subsample, only more delayed. The responses of home mortgages have become smaller. One possible story would be that financial innovation is behind the delay in the reduction of residential investment and the disappearance of the drop
in GDP following a monetary tightening. There are a couple reasons, however, to doubt this interpretation.

(a) Although there are measures that indicate that the reduction of home mortgages has become smaller, it is not clear that this actually is the case. If the drop in home mortgages has not become smaller, then it is not clear how this could have been behind the reduction in the output response. The first indication that the mortgage response has not become smaller is that, as is documented in Figure 10, initially the reduction in home mortgages is actually larger in the second subsample. This is even true when the response of home mortgages is not scaled by the size of the monetary policy shock. More importantly, the reduction in the drop of home mortgages following a monetary tightening is not robust. For several VAR specifications, we find that the drop in home mortgages is similar to the drop observed in the first subsample even though the increase in the federal funds rate is much smaller.\(^{10}\) Finally, it is not clear whether the percentage change in home mortgages is the right measure given that home mortgages have increased sharply relative to GDP and relative to the level of residential investment. That is, the same percentage reduction in home mortgages corresponds to a much larger drop in the amount of home mortgages relative to GDP in the second subsample. Scaled for the size and persistence of the federal funds rate responses, we find that the largest reductions for home mortgages are equal to 0.71% and 0.43% in the first and second subsample, respectively. But the ratio of average mortgages relative to average GDP is in the second subsample 193% higher than in the first subsample. Consequently, the maximum reduction in home mortgage relative to GDP is equal to 0.19% in the first subsample and equal to a somewhat larger drop, namely 0.22%, in the second subsample. If we calculate the drop in mortgages relative to the level

\(^{10}\)The response of home mortgages is related to the drop in GDP. For those VAR specifications with which the response of GDP is not positive, we also find a more negative response for home mortgages, that is, a response that is closer to the response observed in the first subperiod.
of residential investment, then we find that the maximum reduction in home mortgage is equal to 3.95% in the first subsample and equal to a substantially larger reduction, namely 4.77%, in the second subsample.

(b) If financial innovation—through a smaller reduction in home mortgages—is behind the smaller responses of durable expenditures and GDP, then it is somewhat surprising that the drop in residential investment did not become smaller. It is not impossible of course. For example, financial innovation may have made it possible for households to face a smaller decrease in their home equity loans and that this made it possible to have a lower reduction in durable expenditures, but that their access to home mortgages to finance residential investment was unchanged.

(c) There is one more reason to believe that financial innovation in the market for home mortgages is not behind the smaller responses of durable expenditures and GDP and that is that there is a plausible alternative explanation. The alternative explanation is that home mortgages drop by less, because there is no longer a sharp immediate reduction in real activity. To check the validity of this story, we plot in Figure 11 the IRF of home mortgages for the second subsample when the economy faces a series of monetary policy and real activity shocks such that the IRF for the federal funds rate and the three real activity variables are identical to the one observed in the first subsample. The figure also plots the original IRF of home mortgages during a monetary tightening in the second subsample. The figure shows that the drop of home mortgages in the second subsample is a lot stronger than in the first subsample. That is, corrected for the changes in the responses of the real activity variables and the federal funds rate, the observed reductions in home mortgages are actually large relative to the responses of the first subsample.

2. Consumer credit: Whereas for home mortgages there clearly still is a substantial contraction in the second subsample, the negative response of consumer credit following a monetary tightening has disappeared in the second subsample. Moreover,
this is a robust result. Is this change, together with the other results, evidence of financial innovation?

(a) The changes in the results for consumer credit clearly fit the standard financial innovation story a lot better than the (lack of) changes for home mortgages and residential investment. That is, it is possible that financial innovation in the market for consumer credit has made it easier to keep on extending credit when interest rates increase and that this is behind the disappearance of the economic downturn following a monetary tightening. To see whether there is some support for the hypothesis that the vanishing reduction in loans are important for the disappearance in the reduction of durable expenditures and GDP, we recalculate the IRFs in the first subsample by resetting the loan responses equal to zero in each period. The results are reported in Figure 12.\textsuperscript{11}

The graph makes clear that consumer credit has basically no effect on either durable expenditures or GDP, at least not when this effect is measured by the direct effect of consumer credit in the VAR equations. So although there are some aspects of the changes that are consistent with the standard story about the consequences of financial innovation, there are some aspects that do not quite fit the story.

(b) An alternative story to tell is that the responses of several expenditure components to a monetary policy shock have become smaller, because, for example, prices have become less sticky. The response of consumer credit is then smaller, because the smaller reduction in expenditure components corresponds to a smaller reduction in the demand for consumer credit and faced with a smaller economic downturn financial institutions see less reason to reduce the supply of credit. Support for this claim is given in Figure 13 that plots the IRF of consumer credit when we feed the VAR of the second subsample a sequence.

\textsuperscript{11}One can only obtain very limited information from these exercises. The reason is that the coefficients of other variables in the GDP and durable expenditure equation, like the coefficient on the federal funds rate, may also capture the effect from the loan market on real activity.
of monetary policy and real activity shocks such that the IRFs of residential investment, durable expenditures, GDP, and the federal funds rate are identical to those observed in the first subsample. For this set of shocks, we find that the predicted responses of consumer credit in the second subsample are stronger than the responses observed in the first subsample.$^{12}$

In this paper, we argue that if financial innovation has had a major impact on the business cycle behavior, then it should show up in the estimated dynamic system characterized by IRFs. One aspect that did change is that the variance of monetary policy shocks has become smaller. Above we compared the results in the two subsamples for equal changes in the federal funds rate. But the question arises why monetary policy shocks became smaller and whether the reduction in its variance could be related to financial innovation. For example, if financial innovation leads to a healthier financial sector, for example, because of better diversification, then there is less reason for the central bank to change the interest rate solely because of reasons related to the health of the financial sector. The recent subprime mortgage crisis makes clear that, if it ever was so, it no longer is true. Moreover, given that there are other plausible reasons, like the increased understanding on the importance of rules instead of discretion, this seems not very convincing evidence that financial innovation has changed business cycle properties.

5.2.2 Financial innovation and changes in non-monetary IRFs

In this section, we discuss the changes in the other IRFs and check whether the changes are consistent with the hypothesis that financial innovation has changed business cycle properties.

Results based on real activity shocks. The general shape of the IRFs following a real activity shock seems quite similar across the two subsamples, except that the magnitudes are smaller in the second subsample. When we take a closer look, however, then there seem to have been some changes. In the first subsample, the three real activity variables as

$^{12}$Note that we found a very similar result for home mortgages.
well as the two loan components display an initial decrease followed by a quite substantial increase. During the initial economic downturn, the federal funds rate drops by 50 basis points, which could be the reason for the subsequent expansion. In the second subsample, the observed pattern is very similar, except that the sign switch for the responses of home mortgages occurs much faster (in fact, there barely is an initial negative response) and the responses of the three real activity variables also turn positive earlier (although all three are still significantly negative for several periods).

Although the shortening of the economic downturn, i.e., the leftward shift of the IRFs, seems relatively small, it does fit the standard story that financial innovation has dampened the impact of shocks. The idea would be that because of financial innovation home mortgages only display a minor initial response and in fact quickly increase in response to this negative real activity shock. This upward shift of the response in home mortgages shortens and possibly dampens the economic downturn. In terms of statistical significance, the shifts are not substantial and we do not consider this to be strong evidence in support of the hypothesis that financial innovation has changed business cycle properties.

Although the shift in the IRFs seems relatively minor, it is in fact quantitatively important for the change in the covariance between the loan components and the real activity components, a statistic that has received attention by papers that focus on financial innovation and changing business cycle behavior. We will discuss this in more detail below, but note that the range of forecast horizons at which the home mortgage and the GDP responses have the opposite sign is larger in the second than in the first subsample.

**Price shock.** The changes in the IRFs after a price shock are close to the opposite of what one would expect if financial innovation had affected business cycle properties. If anything, the loan responses had become more negative and the GDP response had become slightly less negative, but more persistent. The responses of residential investment and durable expenditures even had become more negative and those of durable expenditures significantly so. A much more straightforward explanation for this change is that the FED has become more responsive to inflationary pressure, which explains the upward shift of the response of the federal funds rate, which in turn explains the downward shift of the
responses of the two loan components and the associated spending categories.

**Consumer credit shock.** Similar to the results for prices, the IRFs are typically not significant and if anything are not consistent with standard theories about the impact of financial innovation. In particular, the drop in consumer credit has only become larger and more persistent, whereas the IRFs of the three real activity variables have become more muted.

**Home mortgage shock.** There are some aspects to the changes in the IRFs of a home mortgage shock that resemble the discussion above for the changes in the IRFs of a price and a consumer credit shock. In particular, we find that the reduction in home mortgages has clearly increased, the response of residential investment is significantly negative in the second subsample compared to significantly positive in the first subsample, and the responses of durable expenditures and GDP have become slightly less negative. Standard stories about the effects of financial innovation would not predict these larger negative responses to home mortgages and residential investment.

If we take into account the response of consumer credit, however, the case for financial innovation becomes stronger. In the first subsample, the reduction in home mortgages goes together with a reduction in consumer credit (although not a significant one). In contrast, in the second subsample, the reduction in home mortgages goes together with a sharp and significant increase in consumer credit. One possible story would be that because of financial innovation the financial sector has been much better capable of reallocating resources between its different assets if, for one reason or another, one particular asset becomes less attractive. One could then say that this increased reallocation into consumer credit is the reason for the reduction in the negative responses of durable expenditures and GDP.
5.2.3 Financial innovation and changing covariances

The sharp drop in the covariance between consumer loans and GDP has been used to support the hypothesis that financial innovation has affected business cycles.\textsuperscript{13} In this section, we use the estimated IRFs to explain why the covariance has dropped and whether this explanation is consistent with financial innovation.

We focus mainly on the comovement statistics of den Haan (2000), because they provide a direct connection between the correlation coefficients at the different forecast horizons and the IRFs. The analysis turns out to be remarkably simple, because there are only two shocks that turn out to matter for most of the results: the monetary policy shock and the real activity shock. Figure 14 plots the correlation coefficient between home mortgages and GDP (top panel) and the correlation coefficient between home mortgages and residential investment (bottom panel). It plots the results for the first and the second subsample. It also plots the contribution of the monetary policy shock and the real activity shock. When we add up the two corresponding curves, then we are very close to the total, so the other shocks contribute very little to the comovement between home mortgages and these two real activity variables.\textsuperscript{14} First consider the correlation with GDP, which is plotted in the top panel. In the first subsample, the positive correlation between home mortgages and GDP is mainly due to monetary policy shocks. A significant part is also due to real activity shock: at higher forecast horizons the real activity shocks explain roughly one third of the total correlation, but at shorter forecast horizons it is more. In the second subsample, the correlation has turned negative and this is due both to a change in the sign of the comovement due to monetary policy shocks and to a change in the sign of the comovement due to real activity shocks. In itself, a change in the sign could very well be consistent with financial innovation. If financial innovation makes it possible to increase mortgages following a monetary downturn and this in turn leads to a lower reduction in real activity, then this would make the correlation between the two variables positive.

\textsuperscript{13}See, for example, Campbell and Hercowitz (2006) and Iacoviello and Pavan (2008).

\textsuperscript{14}The only exception is the correlation between home mortgages and residential investment in the second subsample.
From the discussion above, however, we know that this is not what is behind the sign change for the comovement due to monetary policy shocks. This comovement has not become negative, because the responses of mortgages have become positive, but because the responses of GDP have turned slightly positive. The responses of mortgages are still significantly negative and, as documented above, the magnitudes in the second subsample are, compared to those observed in the first subsample, still substantial.

The drop in the correlation due to real activity shocks is due to the sign switch in the response of home mortgages occurring earlier. As explained above, this could be consistent with financial innovation, but the shifts in the IRFs are not substantial.

The correlation between home mortgages and residential investment drops by much less than the correlation between home mortgages and GDP. In itself not in support for the idea that financial innovation was behind the drop in the correlation. For the comovement statistic reported here, the drop occurs mainly at shorter forecast horizons. As for the correlation between home mortgages and GDP, the comovement generated by monetary policy shocks drops considerably.

We now turn to consumer credit. Figure 15 gives the results for the correlation between consumer credit and GDP (top panel) and between consumer credit and durable expenditures (bottom panel). Again, the monetary policy and real activity shocks drive most of the comovement. But there are several differences with the results for home mortgages. First, compared to the results for home mortgages, real activity shocks play a relatively more important role for the comovement. This is true both for the correlation with GDP and for the correlation with durable expenditures. Second, in contrast to the correlation between home mortgages and residential investment, the correlation between consumer credit and durable expenditures does drop substantially.

As argued above, the changes in the IRFs following a monetary policy shock could be interpreted as the result of financial innovation (although we also discussed an alternative explanation). When we look at a real activity shock and the IRFs of consumer credit

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15 As for home mortgages, the exception is the correlation between the loan variable and the associated spending component in the second subsample.
and the real activity variables, then it is difficult to see these changes as a consequence of financial innovation. Comparing the results in the second subsample with the results in the first subsample, we see that for consumer credit it takes longer before the response turns positive, that for durable expenditures it happens quicker, and that for GDP it takes roughly the same amount of time. This results in consumer credit and the real activity variables having the same sign for a shorter time period, which implies a lower correlation. But the more persistently negative response of consumer credit is not the type of change one would expect if financial innovation would play a role in dampening the shocks. Given the large role of real activity shocks for the comovement of consumer credit and real activity, financial innovation seems, thus, not a very plausible explanation for the drop in the comovement.

5.2.4 Summary

There are obvious limitations to an informal discussion like the one given here and one should be careful drawing strong conclusions. Nevertheless, we believe that there are some important lessons to be learned about the role of financial innovation for the changing business cycle behavior. The most important one is that—up to the crisis in the market for subprime mortgage markets—there is more support for the view that changes in the market for consumer credit had been instrumental in affecting the business cycle behavior of key macroeconomic variables, than for the view that changes in the market for home mortgages had done so. But even for consumer credit, the evidence that financial innovation is behind the observed changes in cyclical behavior is far from overwhelming.

A Appendix A: real activity shocks

Our VAR contains three real activity variables: residential investment, durable expenditures and GDP. For each of these variables, our Cholesky decomposition gives rise to an associated shock. In the main part of this paper, we analyze the IRFs when each of the three innovations is equal to one standard deviation. In this appendix, we discuss the responses to the three individual shocks. The corresponding IRFs are shown in Figures
Residential investment shock The general shape of the IRFs following a residential investment shock seems quite similar across the two subsamples. In the first subsample, the three real activity variables as well as the two loan components display an initial decrease followed by a quite substantial increase. The same pattern is found for the responses to a real activity shock, as discussed in the main text. Similar to the change observed for the responses to a real activity shock, the responses of home mortgages to a residential investment shock seems to have shifted upward and turn positive earlier. In itself this is consistent with financial innovation, but comparing the IRFs for residential investment and GDP across the two samples indicates that there is not a substantial reduction in the economic downturn and that the drop in GDP even has become a lot more persistent. In fact, relative to the IRFs reported in the main text for a real activity shock, these results provide less evidence in favor of the hypothesis that financial innovation is behind the reduction in real activity.

Durable expenditure shock When we compare the changes in the responses of durable expenditures and GDP to a durable expenditures shock with the changes in the corresponding responses to a real activity shock, then we find that the reduction of the negative responses are stronger for the first set. This would strengthen the case for financial innovation having had an impact on business cycle behavior. When we compare the responses of consumer credit to a durable expenditures shock with the responses of consumer credit to a real activity shock, then we find that the responses to a durable expenditures shock are very similar across the two subsamples. With an almost equal reduction in consumer credit, the evidence that financial innovation is behind the smaller reductions in real activity is again weaker for the responses to the individual shock, then for the joint real activity shock.

GDP shock Whereas the evidence that financial innovation had reduced the impact of shocks was weaker for the last two separate shocks than for the joint real activity shock,
the evidence is somewhat bigger for the GDP shock. Now the upward shift in both the loan and the real activity is larger, except for residential investment. The overall pattern of results, however, is very similar to the one discussed in the main text.

References


Figure 1: Household loans

Notes: Panel A of this figure plots the loan variables as a percentage of GDP. Panel B plots home mortgages and consumer credit as a percentage of respectively the value of real estate and the value of durables owned by households.
Notes: Panel A to D plot the cyclical components of home mortgages, consumer credit, residential investment and durable expenditures. Each of these panels also plots the cyclical component of GDP (grey line). Panel E plots the federal funds rate. Cyclical components are calculated using the HP filter with $\lambda = 1600$. 
Figure 3: Comovement between home mortgages and real activity.

A. Correlation between home mortgages and GDP

B. Correlation between home mortgages and residential investment

Notes: Correlation of forecast errors at different forecast horizons according to the benchmark VAR.
Figure 4: Comovement between consumer credit and real activity.

A. Correlation between consumer credit and GDP

B. Correlation between consumer credit and durable expenditures

Notes: Correlation of forecast errors at different forecast horizons according to the benchmark VAR.

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Figure 5: IRFs following a monetary tightening

Notes: Responses to a one standard deviation shock in the federal funds rate.
Notes: Responses to a simultaneous one standard deviation shock in residential investment, durable expenditures and GDP.
Figure 7: IRFs following a consumer credit shock

Notes: Responses to a one standard deviation shock in home mortgages.
Figure 8: IRFs following a home mortgage shock

Notes: Responses to a one standard deviation shock in consumer credit.
Notes: Responses to a one standard deviation shock in the price level.
Figure 10: IRFs of home mortgages and residential investment
(with same interest rate response as in early sample)

Notes: This figure plots the IRF of home mortgages in the first sample following a monetary tightening and the IRF of home mortgages in the second sample when the economy faces a sequence of monetary policy shocks such that the IRF of the federal funds rate is identical to the one observed in the first subsample during a monetary tightening.
Figure 11: IRFs of home mortgages
(with same interest rate and real activity responses as in early sample)

Notes: This figure plots the IRF of home mortgages in the first subsample following a monetary tightening and the IRF of home mortgages in the second subsample when the economy faces a sequence of monetary and real activity shocks such that the response of the federal funds rate and real activity variables are identical to those observed in the first sample during a monetary tightening.
Figure 12: IRFs of durable expenditures and GDP (consumer credit remains constant)

Notes: These IRFs are constructed by simply setting the response of consumer credit equal to zero each period.
Figure 13: IRFs of consumer credit
(with same interest rate and real activity responses as in early sample)

Notes: This figure plots the IRF of consumer credit in the first subsample following a monetary tightening and the IRF of consumer credit in the second subsample when the economy faces a sequence of monetary and real activity shocks such that the response of the federal funds rate and real activity variables are identical to those observed in the first sample during a monetary tightening.
Figure 14: Comovement between home mortgages and real activity.

A. Correlation home mortgages and GDP

B. Correlation home mortgages and residential investment

Notes: Correlation of forecast errors according to the benchmark VAR. The graph also indicates the role of monetary policy and real activity shocks.
Figure 15: Comovement between consumer credit and GDP.

A. Correlation consumer credit and GDP

B. Correlation consumer credit and durable expenditures

Notes: Correlation of forecast errors according to the benchmark VAR. The graph also indicates the role of monetary policy and real activity shocks.
Figure 16: IRFs following a residential investment shock

Notes: Responses to a one standard deviation shock in residential investment.
Figure 17: IRFs following a durable expenditures shock

Notes: Responses to a one standard deviation shock in durable expenditures.
Figure 18: IRFs following a GDP shock

Notes: Responses to a one standard deviation shock in GDP.
Table 1: Standard Deviations (in %)

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Notes: The table reports the standard deviation of the cyclical component of the indicated variable. In each sample, the trend used to construct the cyclical component is obtained by applying the HP filter over the whole sample.
Table 2: Correlation coefficients

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Notes: The table reports the correlation between the cyclical components of the indicated variables. In each sample, the trend used to construct the cyclical component is obtained by applying the HP filter over the whole sample.
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