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Abstract

The financial crisis of 2007–09 has highlighted the importance of developments in financial conditions for real economic activity. The authors estimate the effect of current and past shocks to financial variables on U.S. GDP growth by constructing two growth-based financial conditions indexes (FCIs) that measure the contribution to quarterly (annualized) GDP growth from financial conditions. One FCI is constructed using a structural vector-error correction model and the other is constructed using a large-scale macroeconomic model. The authors' results suggest that financial factors subtracted around 5 percentage points from quarterly annualized real GDP growth in the United States in 2008Q4 and 2009Q1 and should subtract another 5 percentage points from growth in 2009Q2. Moreover, to assess the effect of financial shocks in terms of policy interest rate equivalent units, the authors convert the effect of financial developments on growth into the number of basis points by which the federal funds rate has been tightened. The authors show that the tightening of financial conditions since mid-2007 is equivalent to about 300 basis points of tightening in terms of the federal funds rate. Thus, the aggressive monetary easing undertaken by the Federal Reserve over the financial crisis has not been sufficient to offset the tightening of financial conditions. Finally, in a key contribution to the literature, the authors assess the relationship between financial shocks and real activity in the context of the zero lower bound. They find that the effect of the tightening of financial conditions on GDP growth in the current crisis may have been amplified by as much as 40 per cent due to the fact that policy interest rates reached the zero lower bound.

JEL classification: E32, E44, E47, E51
Bank classification: Business fluctuations and cycles; Monetary conditions index; Monetary and financial indicators; Recent economic and financial developments

Résumé

La crise financière de 2007-2009 a mis en lumière l'importance du lien entre les facteurs financiers et l'activité économique réelle. Afin d'estimer l'incidence des chocs financiers présents et passés sur l'évolution de la croissance du produit intérieur brut (PIB) américain, les auteurs construisent deux indices mesurant la contribution des conditions financières à la croissance trimestrielle (en chiffres annuels) du PIB. Le premier est élaboré à l'aide d'un modèle vectoriel structurel à correction d'erreurs, et le second au moyen d'un modèle macroéconomique de grande taille. D'après l'analyse des auteurs, les facteurs financiers auraient retranché environ cinq points de pourcentage du taux de croissance trimestriel annualisé du PIB réel aux États-Unis au quatrième trimestre de

2008 et au premier trimestre de 2009 et devraient en retrancher encore cinq au trimestre suivant. Afin de disposer d'indices reposant sur des unités comparables, les auteurs convertissent leur mesure de l'effet de l'évolution financière sur la croissance en une mesure indiquant de combien, en points de base, le taux des fonds fédéraux devrait être relevé pour produire l'effet en question. Ils montrent ainsi que le resserrement des conditions financières observé depuis la mi-2007 équivaut à une augmentation d'environ 300 points de base du taux des fonds fédéraux. La forte détente monétaire opérée par la Réserve fédérale américaine durant la crise financière n'a donc pas suffi à faire contrepoids au durcissement des conditions financières. Enfin, une contribution importante de l'étude est l'évaluation des implications de l'existence d'une borne inférieure limitant les taux directeurs à zéro pour la relation entre les chocs financiers et l'activité réelle. Selon les auteurs, le fait que les taux directeurs aient atteint leur valeur plancher a pu amplifier de pas moins de 40 % l'incidence du resserrement des conditions financières sur la croissance du PIB au cours de la crise.

Classification JEL : E32, E44, E47, E51
Classification de la Banque : Cycles et fluctuations économiques; Indice des conditions monétaires; Indicateurs monétaires et financiers; Évolution économique et financière récente

1 Introduction

The U.S. and the global economy are undergoing one of the worst financial crises in the postwar era. After the failure of Lehman Brothers in September 2008, spreads on corporate bonds widened dramatically, and non-price lending standards tightened. Financial wealth plummeted from its 2007Q3 peak, largely as a result of the dramatic falls in equity markets. On top of this, the financial crisis led to a portfolio shift towards low-risk, highly liquid assets, which increased capital inflows into the United States, resulting in a marked appreciation of the U.S. dollar in late 2008. These worsening financial and monetary conditions resulted in a significant slowdown in economic activity in the United States. The policy response has been commensurably vigorous: the federal funds rate is currently at its lowest historical value, a large fiscal stimulus package has been enacted, and the Federal Reserve has undertaken credit and quantitative easing.

Tracking developments in the financial sector and estimating the impact on the real economy have become increasingly difficult. Not only are the range of financial disruptions more pervasive and the number of countervailing policy actions greater, but financial market shocks may have asymmetric and non-linear impacts on GDP growth, along with varying transmission lags. In this paper, we develop a single summary measure to assess the impact of financial conditions on U.S. GDP growth. We do this by estimating the effect of current and past shocks to financial variables on GDP growth, and construct two growth-based financial conditions indexes (FCIs) that measure the contribution to quarterly (annualized) GDP growth from financial conditions.

The first FCI is constructed using a structural vector error-correction model that is similar to the vector autoregression (VAR)-based methodology of Swiston (2008). However, we improve on his method by allowing for long-run relationships between the financial variables and by ensuring that the variables included in our VAR are stationary.

The second FCI is constructed using a large-scale macroeconomic model – the Bank of Canada's MUSE (Model of the U.S. Economy; see Gosselin and Lalonde 2005) – in which financial variables affect output in a general-equilibrium framework.

Comparing the results of the two FCIs, we show that financial conditions have had a large negative impact on U.S. GDP growth in the current recession and that recent shocks to financial conditions are likely to continue to exert a sizable drag on GDP growth over the next quarters. In particular, our FCIs suggest that financial factors subtracted between 4 and 7 percentage points from quarterly annualized growth in 2009Q1.

Moreover, our approach allows us to convert our growth-based FCI indexes into FCIs that measure the Federal Reserve's effective policy stance in terms of the federal funds rate. This allows us to measure how well monetary policy has offset the tightening of financial conditions over the financial crisis. We show that the recent tightening of financial conditions is equivalent

to about 300 basis points of tightening in terms of the federal funds rate. Thus, the monetary easing undertaken by the Federal Reserve over the recent financial crisis has not been sufficient to offset the tightening of financial conditions.

Lastly, the structure of MUSE allows us to explore the implications of the lower bound on nominal interest rates on the relationship between financial shocks and the real economy. To the best of our knowledge, this is the only paper that explores the implications of the lower bound on the contribution to growth from financial conditions within the context of an FCI. Abstracting from credit and quantitative easing, we show that when nominal interest rates have reached the lower bound, the impact that a tightening of financial conditions has on GDP will be greater than when policy rates are above the lower bound. At the lower bound, the Federal Reserve cannot respond to negative financial shocks by adjusting policy rates; therefore, negative financial shocks tend to lower inflation and increase real interest rates. The higher level of real interest rates has a more dampening effect on economic activity relative to when nominal policy rates can respond to financial shocks. We show that, in the current recession, the Federal Reserve's inability to adjust nominal interest rates in response to negative financial shocks may have increased the negative impact on economic activity associated with financial conditions by up to 40 per cent. However, since our analysis excludes the numerous non-traditional policies implemented by the Federal Reserve and the U.S. Treasury in this crisis, this should be viewed as an estimate of the upper bound of the impact of financial conditions on economic activity.

The remainder of this paper is organized as follows. In section 2 we provide a brief review of the literature on FCIs, and in section 3 we describe the methodology employed in this paper. We discuss our two benchmark FCIs in section 4. In section 5, we extend our benchmark FCIs by including housing wealth which, through collateral effects, can affect the economic outlook. In section 6, we present our FCIs in terms of policy interest rate equivalent units. In this way, we examine the effective tightening over current and past cycles from financial shocks measured in terms of the short-term policy interest rate. In section 7 we discuss the implications of financial shocks for GDP growth in the context of the zero lower bound, and in section 8 we conclude.

2 Literature Review

A number of studies have estimated FCIs to measure movements in financial conditions. Early research in this area built on monetary conditions indexes (MCIs) that measure changes in monetary conditions related to movements in the policy interest rate and the exchange rate by augmenting the MCIs with financial variables. Among the financial variables considered have been equity wealth (e.g., Dudley and Hatzius 2000), borrowing spreads, and housing prices (Goodhart and Hofmann 2001; Gauthier, Graham, and Liu 2004). More recently, lending standards have also been included in FCIs to account for non-price credit conditions (Swiston 2008; Guichard and Turner 2008). The path of financial conditions suggested by various FCIs may thus differ substantially due to differences in the financial variables included. Building on

recent studies, we consider price and quantity measures of credit in our FCIs as well as movements in housing and financial wealth.

In addition to differences in the variables included, the definition of FCIs differs substantially across methodologies. While some researchers compute FCIs that measure the tightness/accommodativeness of financial factors relative to their historical average in terms of an effective policy rate (e.g., Guichard and Turner 2008), others measure the estimated contribution to growth from financial shocks in a given quarter (Swiston 2008). Our approach is unique in that we compute two FCIs that measure the contribution to growth in a given quarter from financial shocks that we are able to convert into FCIs that measure the tightness of financial conditions in terms of an effective policy interest rate. Thus we are able to compare movements in our two FCIs with a wide range of FCIs computed by other researchers. Moreover, our two FCIs are more informative in that they can comment on the effect of financial conditions on real activity as well as on the effective policy stance, rather than on one or the other.

Three main approaches have been used in the literature to estimate the effect of shocks to financial conditions on GDP growth: (i) aggregate demand equations, (ii) simulation from large-scale macroeconomic models, and (iii) impulse-response functions from vector autoregressions. Key papers and brief descriptions of the approaches are reported in Table 1.

Each approach has comparative advantages and disadvantages.

FCIs constructed using aggregate demand equations are usually derived from an IS curve, relating the output gap to interest rates, exchange rates, and asset prices, as well as a Phillips curve. Financial variables are generally included in these models based on their statistical significance, with the coefficients on the financial variables determining the weight of each variable in the FCI. As such, FCIs constructed using aggregate demand equations rely on the simple assumption that all financial variables are exogenous to each other and to the real economy. As pointed out by Gauthier, Graham, and Liu (2004), these types of FCIs may therefore suffer from estimation bias and/or identification problems.

The VAR and large-scale macroeconomic model approaches determine the weight of each financial variable in the FCI using the estimated impact of observed shocks to each financial variable on economic activity.[1] These approaches offer a few key advantages over the aggregate demand equation approach. First, unlike the aggregate demand equation approach, they account for the impact of shocks to financial variables on other variables included in the model. This allowance for interlinkages between variables may be particularly important when considering financial variables, since there are several theoretical relationships between financial variables (e.g., the expectations hypothesis of the term structure of interest rates). FCIs constructed using

1. Specifically, the FCI weights are calculated by combining the estimated shock to each variable from the model with the estimated impulse-response function.

VARs and large-scale models may thus overcome the potential estimation bias and may reduce potential identification problems of aggregate demand equations, since they are constructed based on models in which all variables are endogenous.

Table 1
Summary of Previous Work to Construct Financial Conditions Indexes[1]

Study	Countries covered	Financial variables included	Comments
Dudley and Hatzius (2000)	United States	Stock market capitalization/GDP	Weights based on GDP effects derived from Fed's macro model
Goodhart and Hofmann (2001)	Each of the G-7	Real housing prices, real U.S. equity prices, U.S. high-yield spread	Alternative FCIs calculated both from reduced-form and VAR estimations
Gauthier, Graham, and Liu (2004)	Canada	Real housing prices, real U.S. equity prices, U.S. high-yield spread	Alternative FCIs calculated from reduced-form, VAR estimations, and factor analysis
Mayes and Virén (2001)	11 European countries	Real house prices, real asset prices	Reduced-form equations
Swiston (2008)	United States	Lending standards, corporate bond yields, equity prices, exchange rate	VAR estimations
Guichard and Turner (2008)	United States	High-yield bond spread, lending standards, the real exchange rate, stock market capitalization	"Hybrid approach:" Reduced-form estimation with some macro model calibration, compared to VAR estimations

[1]Adapted from Guichard and Turner (2008)

Another advantage of FCIs constructed using VAR and large-scale macroeconomic models is their ability to capture the dynamic response of economic growth to financial variables. In contrast, FCIs calculated using aggregate demand equations generally neglect dynamic effects by summing each variable's contemporaneous and lagged coefficients in the model to determine

their effect on economic growth, thus failing to identify the timing of the impact on economic activity.

An advantage of FCIs constructed using simulations from large-scale macroeconomic models is their ability to capture key structural features of the economy. However, this advantage is limited to a certain extent by the fact that many large-scale macroeconomic models do not include a wide range of financial variables. If real-financial linkages are not well specified in the macro model, the performance of a model-generated FCI will also be poor.

3 Methodology

In this paper, we construct two FCIs for the United States. One FCI is constructed using orthogonalized impulse-response functions from a structural vector error-correction model (SVECM). The other FCI is constructed using a large-scale macroeconomic model: the Bank of Canada's MUSE (Gosselin and Lalonde 2005). Thus, taking into account the advantages and disadvantages of each methodology discussed in the previous section, we are able to compare the estimated effect of financial conditions on economic growth.

The Bank of Canada uses MUSE to forecast developments in the U.S. economy. The model is a system of estimated equations that describe interactions among the principal macroeconomic variables such as GDP and its components, inflation, interest rates, and the exchange rate. MUSE incorporates several financial variables that affect consumption and investment demand, including: the federal funds rate, the conventional mortgage rate, housing and financial wealth, and an investment-grade corporate bond rate. Moreover, the model includes a role for credit availability in the dynamic equations for consumption and for residential and business investment.[2] Most importantly, the impact of financial shocks on the real economy is incorporated in a comprehensive general-equilibrium framework.

Both FCIs are created by combining the estimated response of GDP growth with the structural shocks associated with each financial variable. That is, the impulse-response functions from the SVECM and MUSE for each financial variable are combined with the measure of structural financial shocks to compute the FCIs. In the SVECM and in MUSE, shocks refer to the estimated structural shocks generated by the respective models, since most of the financial variables are endogenous. The exception is the credit standard variables in MUSE. Therefore, the structural shocks for these components are computed by taking the first difference of the net percentage of banks indicating a tightening of lending standards in the Federal Reserve's Senior Loan Officer Opinion Survey on Lending Practices (SLOS). In the SVECM, we assume that only past shocks to financial variables affect GDP growth in the current period; however, with the

2. As measured by the net percentage of banks indicating a tightening in lending standards in the Federal Reserve's Senior Loan Officer Opinion Survey on Lending Practices.

MUSE-based FCI, current quarter shocks are allowed to affect the computation of the FCI at time *t*.[3] The FCI is given by equation (1):

$$FCI_t = \sum_{j=1}^{n}\left(\sum_{i=1}^{m}(r_{t,jt-i})\right). \quad (1)$$

In equation (1), $r_{t,jt-i}$ measures the response of GDP growth in the FCI to each variable *j* in period *i*.[4] Therefore, $r_{t,jt-i}$ represents the response of GDP growth in a given quarter to a financial shock occurring in the previous quarter. To calculate the index, we sum the response of GDP growth to each financial shock over *m* time periods and then sum the response of GDP growth to the *n* financial shocks included in the FCI.[5] In this way, the index measures the contribution to GDP growth in a given quarter from shocks to financial variables over the previous *m* quarters.

4 Results

4.1 SVECM-based FCI

The starting point for the FCI constructed using the SVECM approach is a small VAR including real GDP, the GDP deflator, and the commercial paper rate. The VAR is then augmented to include financial variables capturing the price and quantity channels of credit restrictions. A variety of financial variables were examined. The final specification includes only financial variables that were found to have a significant effect on GDP growth.[6] These are the commercial paper rate, the business borrowing spread, loan standards for consumer spending, and financial wealth.

We tested for cointegration among the variables in the VAR, and found a cointegrating relationship between the business borrowing spread and lending standards for consumer spending, with the direction of causality running from the business spread to lending standards.[7] We therefore estimated our model as a SVECM allowing for this cointegrating relationship.

Note that the short-term interest rate in the SVECM is the real commercial paper rate instead of the federal funds rate, since the focus of the FCI is on the impact of economy-wide financial conditions on economic growth, rather than the effect of monetary policy.[8,9]

3. In the SVECM model, this is due to the primacy of GDP in the Cholesky ordering.
4. This equation differs slightly from that in Swiston (2008): our SVECM is estimated in growth rates, while Swiston's VAR is estimated in levels.
5. *M* is chosen based on the number of quarters it takes for the impulse-response function from a given shock (on the level of GDP) to level out.
6. Other variables that were examined but rejected in the final specification include: real oil prices, the real federal funds rate, a high-yield bond spread, a mortgage rate, and the real effective exchange rate.
7. The cointegrating term in the business borrowing spread equation in the SVECM was not statistically significant.
8. Appendix A provides a description of the data used in these calculations.
9. Note that Swiston (2008) uses the 3-month LIBOR, instead of the federal funds rate, in his FCI.

The yield on investment grade corporate bonds (Moody's BAA) less the yield on Treasuries of a similar maturity is used to measure the business borrowing spread. Financial wealth is derived from the Federal Reserve's Flow of Funds Accounts, rather than using stock market prices, as is typically done since financial wealth is the variable found in MUSE. This facilitates comparison between our two FCIs. Moreover, financial wealth includes stock market wealth.[10]

Following the recent tradition of including survey measures of the tightness of credit conditions in FCIs (Guichard and Turner 2008; Swiston 2008), we include the net percentage of banks reporting tightening consumer loan standards from the Federal Reserve's SLOS in our FCI. We include consumer loan standards in our SVECM because they are available over a longer sample period (1979Q3–2009Q1) than are loan standards on consumer and industrial loans, for instance. This choice enables us to estimate our SVECM-based FCI (SFCI) over a longer sample period, in order to look at the role of financial conditions in more business cycles. Although Swiston (2008) finds that commercial and industrial loan standards are the only credit standards that have a statistically significant effect on economic activity, this is likely a function of the estimation period used (1990Q2–2008Q1), since we find that consumer loan standards have a statistically significant effect on economic activity over our longer sample period (1979Q3–2009Q1). Given that the different categories of loan standards are highly correlated, the FCI should be relatively robust to the choice of the lending standards variable.

We estimate our SFCI with four lags. According to unit root tests, all variables of the model are stationary in first differences, with the exception of the real commercial paper rate, which is stationary.[11] Therefore, all variables enter the model in first difference with the exception of the real commercial paper rate, which is included in levels. We order the variables in the SVECM based on their relative exogeneity at time *t*; that is, according to the perceived degree to which they respond to movements in other variables. This allows us to compute orthogonalized impulse-response functions using the Cholesky decomposition. The variables are included in the SVECM in the following order: output, inflation, commercial paper rate, business borrowing spread, loan standards for consumer spending, and financial wealth. As is typical in the literature, the financial variables are ordered after the other variables in the SVECM, which assumes that financial variables do not affect output or inflation at time *t*. This is a reasonable assumption given that financial variables should affect output with long lags.

Since we compute our orthogonalized impulse-response functions using the Cholesky decomposition, the magnitude of the structural shocks to variables, the impulse-response functions, and our SFCI will depend to some extent on the assigned ordering of the variables in

10. The disadvantage of financial wealth versus stock market wealth is, however, that stock market wealth data are available earlier and are not revised, while financial wealth data frequently undergo large revisions. In our quest for our final specification, we did examine the total return on the S&P 500 index (including reinvested dividends), and found that it yielded results similar to those for financial wealth.
11. Including the first difference of the real commercial paper rate, rather than the level, did not have a large effect on the path of the SFCI.

the SVECM. Sensitivity analysis conducted around the ordering of the financial variables suggests that the impulse-response functions and the resulting SFCI are robust to the ordering of the variables in the SVECM.[12]

In Chart 1, the impulse-response functions show the effect of a one standard deviation shock to each of the financial variables on the level of GDP. The results suggest that there are strong real-financial linkages. Looking first at the effect of the commercial paper rate on the level of GDP, we see that a one standard deviation increase in the commercial paper rate (75 basis points) decreases GDP by about 0.35 per cent after one year. This response to the commercial paper rate is comparable to the response of GDP to the 3-month LIBOR in Swiston (2008). Economic activity also responds to the business borrowing spread, with a one standard deviation increase (21 basis points) resulting in a reduction in GDP by about 0.50 per cent after a year and a half.

In addition to financial variables reflecting the price of credit, financial variables reflecting the quantity of credit available and financial wealth are also found to have important effects on economic activity. A one standard deviation increase in lending standards (a net tightening of 8.6 percentage points) reduces the level of GDP by about 0.6 per cent after roughly two years, while an increase in financial wealth of 2.9 per cent (one standard deviation) increases GDP by about 0.7 per cent.[13]

We combine the impulse-response functions with the model's estimated structural shocks to each variable to form our SFCI.[14] As noted earlier, the SFCI measures the total contribution to growth in a given quarter from financial conditions. In calculating the SFCI, we allow shocks to financial variables from the previous eight periods to affect GDP growth. In a sensitivity analysis, we confirm that our results are relatively robust to the choice of lag length. Given that the effect of most of the financial variables on GDP has levelled out after approximately eight periods (Chart 1), allowing financial shocks to affect GDP over a longer period does not have a large effect on our FCI.

Given that the SFCI is measured in terms of its contribution to economic growth, it can distinguish between tight financial conditions and tightening financial conditions that are still accommodative. A positive value for the index can be interpreted as the annualized contribution to GDP growth in a given quarter from accommodative financial conditions, while a negative value can be interpreted as the annualized reduction in GDP growth in a given quarter from tight financial conditions. Tightening financial conditions that are still accommodative are identified by a decline in a positive value of the SFCI over time. Conversely, loosening financial conditions that are still tight can be identified by an index that becomes less negative over time.

12. Details available upon request.
13. Although not shown, as output falls in response to adverse financial shocks, inflation and nominal interest rates decline.
14. The impulse-response functions showing the effect of a one standard deviation shock to each of the financial variables on the growth rate of GDP are used in this calculation, rather than the effect on the level of GDP as shown in Chart 1.

The SFCI begins in 1982Q1. As Chart 2 shows, the SFCI is highly correlated with quarterly annualized real GDP growth with a contemporaneous correlation of 0.52. Financial variables account for about 32 per cent of the variance in real GDP growth over our sample period. Overall, these findings highlight the importance of financial conditions for economic activity.

From Chart 2, it is clear that tightening financial conditions had a negative effect on economic activity during the recessions of 1982, 1991, 2001, and the current recession that began in 2007. The importance of financial conditions in these recessions is not surprising given the savings and loan crises in the 1980s and 1990s and the stock market collapse of 2000. Moreover, the current recession has been associated with extreme financial volatility following the housing market downturn, subsequent losses on subprime mortgages, and the ultimate failure of large financial institutions, including Lehman Brothers. The SFCI also captures periods of accommodative financial conditions, including over the 2004–06 period, which is characterized by historically low risk premiums.

Chart 3 shows the contribution to growth of each financial variable. Of note is that expansionary monetary policy likely contributed quite strongly to growth over 2003–04, given the strong positive contribution to growth from the commercial paper rate, consistent with research using the Taylor rule that suggests that monetary policy may have been excessively accommodative over this period (Taylor 2007). An increase in financial wealth contributed strongly to growth in the late 1990s, and its subsequent fall was a key factor leading to the 2001 recession. Falling financial wealth has also negatively affected economic growth in the current recession. Moreover, changes in credit availability were a key contributor to economic activity.

The SFCI can also be used to gauge the effect of past financial shocks on future economic activity. To do this, we extend the SFCI until the end of 2010 by carrying forward the effect of already observed shocks to financial conditions on GDP growth. That is, we extend the SFCI to show the impact of past shocks to financial conditions on real GDP growth by assuming that there are no further positive or negative shocks to financial conditions (Chart 3). It is clear that the effects of recent shocks to financial conditions have not yet been fully felt on GDP growth. In particular, lending standards, which began tightening in early 2007, have only recently begun to have a large effect on economic growth. Going forward, the SFCI suggests that the recent decline in financial wealth will also have an important effect on economic activity. Of particular note is the fact that the current crisis is one where all of the components of the SFCI have had an adverse effect on economic activity. This includes the commercial paper rate, since the zero lower bound is preventing monetary policy from offsetting the negative shocks through the interest rate channel.

4.2 MUSE-based FCI

The MUSE-based FCI (MFCI) includes all the financial variables in MUSE: the federal funds rate, the business borrowing rate, the mortgage rate, the real effective exchange rate (REER), financial wealth, and lending standards for consumer spending, mortgages, and business investment.[15]

Chart 4 shows the impulse-response functions of one standard deviation shocks to the financial variables on the level of real GDP. A one standard deviation shock to monetary policy, as identified by a 72 basis point increase in the federal funds rate, reduces the level of real GDP by 0.2 per cent after about a year. Among other financial variables, a one standard deviation shock to the mortgage interest rate (31 basis points) and the business borrowing rate (38 basis points) reduces the level of GDP by 0.07 (after one year) and 0.02 per cent (after two years), respectively. Finally, a one standard deviation positive shock to financial wealth (12.2 per cent) boosts the level of economic activity by about 0.2 per cent after one year.

The effect on economic activity from lending standards depends on the category of lending standards. A one standard deviation shock to consumer loan standards (a net tightening of 6.7 percentage points) reduces the level of GDP by about 0.1 per cent after two years. At the same time, a net tightening of 6.4 percentage points to mortgage lending standards reduces the level of real GDP by about 0.03 per cent. The smaller response of economic activity to lending standards on mortgage loans is related to the fact that residential investment represents only about 2.5 per cent of GDP, while consumer spending represents about 70 per cent of GDP. The effect of lending standards on output can therefore be better understood by considering the effect of a one standard deviation shock to lending standards on the component of output affected by the shock. A one standard deviation shock to consumer lending standards reduces the level of consumer spending by 0.3 per cent after two years, while a one standard deviation shock to lending standards for mortgage loans reduces the level of residential investment by about 1.6 per cent.

Business investment lending standards have two components: investment in equipment and software, and structures investment. A one standard deviation increase in net tightening of loan standards for investment in equipment and software (a net tightening of 10.0 percentage points) reduces the level of investment in this component by 3.4 per cent and the level of GDP by about 0.07 per cent. Moreover, a net tightening of 23.5 percentage points in lending standards for structures investment reduces the level of structures investment by 3.3 per cent and the level of economic activity by 0.05 per cent after about two years.

These findings indicate that the effect of each component of lending standards on output depends on the relative sensitivity of the different components of domestic demand and is proportional to

15. In MUSE, business investment is disaggregated into investment in equipment and software, and structures. Each component of business investment includes a different measure of lending standards in its dynamic equation.

the component's share in GDP. Thus, lending standards have the most important effect on economic activity through lending standards for consumer spending, followed by business investment and mortgages.

The impulse-response functions are combined with the model's structural shocks to each variable to calculate the contribution to growth in a given quarter from financial conditions.[16] Data availability forces us to start our estimation in 1994Q3. This limits the number of business cycles over which we can observe our MFCI.[17] Nevertheless, our MFCI is highly correlated with quarterly annualized real GDP growth, with a contemporaneous correlation of 0.6 (Chart 5). The MFCI suggests that tight financial conditions were a key factor in the 2001 and current recessions. In fact, during the current recession, financial conditions have subtracted more from economic growth than in any other time period covered by either FCI. Despite this finding, our MFCI suggests that financial conditions generally have a smaller effect on economic growth than suggested by the SFCI.[18] Nevertheless, since 1994, 17 per cent of the variance of GDP is explained by financial conditions according to the MFCI.

Since our MFCI includes nine variables, when assessing the contribution of each component of the MFCI we group the four categories of lending standards together. Even when assessing the components of the MFCI, the movements are quite similar to the movements in the SFCI. Both indexes show that expansionary monetary policy contributed strongly to GDP growth over 2003–04 (Charts 3 and 6). More recently, the real federal funds rate is estimated to have subtracted from economic growth. Declines in financial wealth and reductions in credit availability have been the key contributors to the tight financial conditions observed in previous recessions. The real effective exchange rate and the business borrowing rate have not, however, been key drivers of the overall effect of financial conditions on economic activity over the sample period.

The peak adverse effect of financial conditions in the current cycle is expected to have occurred in 2009Q1 (Chart 6). However, this assumes that there are no additional shocks (positive or negative) to financial conditions going forward. Consistent with the SFCI, we also find that the tight lending standards have had the largest negative effect on economic activity in the current cycle, although declining financial wealth has also played an important role.

Despite the fact that lending standards for consumer loans, mortgages, and business investment are highly correlated, they can have different effects on economic activity (Chart 7).[19] For

16. As is the case with the SFCI, the impulse-response functions showing the effect of a one standard deviation shock to each of the financial variables on the growth rate of GDP are used in this calculation, rather than the effect on the level of GDP as shown in Chart 4.
17. The sample period is further restricted due to the fact that the lending standards variables are included in MUSE as moving averages of different lag lengths depending on the standards variable under consideration (see Appendix A).
18. This result may be related to the forward-looking nature of MUSE in that agents may see through some of the shocks to financial conditions.
19. Chart 8 calculates the MFCI and the contributions of the individual components of the MFCI from 2009Q2 onward by assuming that only shocks to financial conditions observed in 2009Q1 and earlier affect economic activity.

example, although all types of lending standards subtracted from economic activity over 2000–01, lending standards for business investment continued to weigh negatively on economic growth for much longer: until the end of 2004. This suggests that a tightening of lending standards for business investment was an important contributor to the extended contraction in business investment activity that took place over that time period. In the current recession, the contributions to growth from the individual components of lending standards confirm our expectations. Mortgage lending standards began weighing negatively on activity in the housing sector before other standards began to have an effect on consumer spending and business investment. This sequence is consistent with the fact that the housing sector correction led the current recession.

4.3 Comparing the two FCIs

The FCIs contain slightly different financial variables (Table 2); however, the overall pattern of financial conditions depicted by the FCIs is quite similar. The correlation between the two FCI series is quite high at 0.77; however, the SFCI is more volatile than the MFCI (Chart 8). A key reason for the greater volatility of the SFCI is the forward-looking nature of the dynamic equations in MUSE, since most of the behavioural equations are governed by a polynomial adjustment cost (PAC) structure (Tinsley 1993).[20] It is precisely because of these adjustment costs that agents are forward looking in MUSE. As a result, agents smooth the profile of the decision variable, which results in less volatility in the MFCI.

Table 2
Financial Variables Included in the FCIs

SFCI	MFCI
Commercial paper rate	Federal funds rate
Business borrowing spread	Business borrowing rate
Lending standards for consumer spending	Lending standards for consumer spending
Financial wealth	Lending standards for mortgage loans
	Lending standards for business investment
	Financial wealth
	Mortgage interest rate
	Real effective exchange rate

20. PAC models decompose the dynamic behaviour of a time series into changes that are induced by expectations and those that are delayed responses to previous decisions. Agents make decisions on the basis of forecasts of the target level of the variable of interest and move towards the target level gradually, due to underlying adjustment costs. Therefore, PAC models are characterized by disequilibrium: the target outcome is not achieved in the short run, despite the fact that agents are rational.

The absolute average contribution to the two FCIs from each financial variable can also be compared (Table 3). In both models, financial wealth is among the most important financial variables for economic growth. This is consistent with Swiston (2008), who finds that real equity returns, on average, explain 18.5 per cent of his FCI's contribution to economic activity. Lending standards also play an important role in economic activity in both models. This finding is also comparable to Swiston (2008), who finds an average absolute contribution from lending standards to his FCI of 22 per cent. Furthermore, in both models, the short-term interest rate explains about 20 per cent of the FCI. The main difference between the two models is the contribution to the FCI from the business borrowing rate, which, on average, is much smaller for the MFCI than for the SFCI. The difference is largely accounted for by the REER and the mortgage rate, which are both important variables in the MFCI that are not included in the SFCI. These results suggest that, despite the fact that the SFCI suggests, on average, a larger contribution to growth from financial conditions, the shares of the FCIs attributed to the different financial variables are consistent across FCIs.

Table 3
Average Absolute Contribution to the FCI
(per cent of total)

SFCI		MFCI	
Commercial paper rate	0.23	Federal funds rate	0.17
Business borrowing spread	0.24	Business borrowing rate	0.03
Loan standards for consumer spending	0.26	Total loan standards	0.33
		Loan standards for consumer spending	(0.12)
		Loan standards for residential investment	(0.03)
		Loan standards for business investment	(0.18)
Financial wealth	0.27	Financial wealth	0.29
		Mortgage rate	0.12
		Real effective exchange rate	0.07

Note: Due to rounding, values may not sum exactly to one.

5 Impact of Housing Wealth on Overall Financial Conditions

The collapse of the U.S. housing market over 2006–09 led to a record fall in housing prices that preceded the wider financial and economic crisis, suggesting that housing wealth (including the effect of a change in the relative price of housing) may also be an important financial variable for the evolution of economic activity. Movements in housing prices may affect consumer spending in two ways: through a direct wealth effect implied by the life-cycle and permanent-income theories, and through a collateral effect, by allowing greater access to credit. Under the permanent-income theory, households perceive their houses as wealth, and base their spending

decisions in part on movements in net wealth positions. As well, if access to credit for some consumers is contingent on their housing wealth or equity, these credit-constrained households will be able to borrow and spend more, based on an increase in the collateral value of their home. To investigate the effect of housing wealth on financial conditions, we have included housing wealth in the MFCI.

The contribution of housing wealth to our FCI has increased more recently. Deregulation of mortgage markets has provided households with greater access to credit and reduced the costs associated with leveraging their home equity, resulting in a stronger link between house prices and consumer spending (Flood, Morin, and Kolet 2008). The increase in the contribution of housing wealth to our FCI is also a function of the record fall in housing prices since 2006, which had a negative effect on GDP growth (Chart 9). This development led to the tightening of other financial conditions in the current cycle, since the housing sector correction was the initial trigger of the current financial crisis in the United States. The housing correction was also associated with a tightening of mortgage lending standards and increased spreads on mortgage loans, which was followed by more broad-based tightening of other financial conditions. In particular, in 2007–08, decreasing housing wealth lowered growth by 0.4 percentage points, on average.

6 Financial Conditions Index in Terms of an Interest Rate Equivalent

For policy-makers, it is not just the contribution to economic activity from financial conditions that matters, but also the effect of financial conditions on their effective policy stance. In the current financial crisis, the Federal Reserve loosened short-term interest rates in an effort to offset the restraint imposed by the rapid tightening of other financial and credit conditions. The degree to which more accommodative monetary policy was necessary to offset the effect of the financial turmoil was, however, difficult to approximate, since there was no single tool available to measure the effect of tight credit conditions. Moreover, there was no measure of the effect of credit conditions in terms of the Federal Reserve's main policy tool: the federal funds rate. In this section, we thus convert past financial shocks, as contained in our two FCIs, into an effective policy stance in terms of a short-term interest rate. This allows us to measure how well monetary policy has offset the tightening of financial conditions over the financial crisis. This follows work done by Guichard and Turner (2008), who developed an FCI in terms of an effective long-term interest rate.

Weights in this interest rate FCI are determined by the estimated impact of a 1-unit change in the relevant financial variable on the level of GDP, averaged over 4–8 quarters, which is then

normalized relative to the effect of a unit change in the short-term interest rate on GDP.[21] Therefore, one can obtain the effective tightening occurring in the economy in terms of the single policy rate. This index is normalized around the historical mean. A positive (negative) number is a tightening (easing) relative to historical norms. In Charts 10 and 11, a unit increase in the index should be interpreted as the impact that a 100 basis point increase in the short-term policy rate would have on GDP.

In the case of our MFCI (Chart 10), we weight all the financial shocks based on their relative impact on GDP, compared to the impact that a unit increase in the federal funds rate would have on GDP. In the SFCI (Chart 11), however, the short-term interest rate is the commercial paper rate. Compared to the estimated response of an increase in the federal funds rate in MUSE, a unit increase in the commercial paper rate has a larger impact on GDP as estimated in the SVECM. Therefore, comparing the financial shocks in the SVECM relative to the commercial paper rate would dampen the magnitude of the index relative to what would be expected by a change in the federal funds rate. Therefore, we show both the impact of financial shocks from the SVECM in terms of the commercial paper rate (denoted SVECM in Chart 12) and the impact of the financial shocks from the SVECM relative to the estimated impact of a federal funds rate increase from MUSE (denoted "SVECM – Calibrated" in Chart 12). However, note that more weight should be placed on the pure MUSE and SVECM results, since these responses are model based rather than calibrated.

From Chart 12, we can see that there has been a significant tightening in terms of "effective interest rate" equivalent units. In the case of the MFCI, financial conditions have tightened by roughly 300 basis points since 2007Q2. This tightening has occurred despite the reduction in the federal funds rate. In the case of the SFCI, financial conditions are roughly 350 basis points tighter than in 2007Q2. However, when we consider financial shocks in the SVECM, relative to the estimated impact of a federal funds rate increase in MUSE, the estimated amount of tightening since 2007Q2 could be as high as 625 basis points. Thus, monetary easing undertaken by the Federal Reserve over the recent financial crisis likely has not been sufficient to offset the tightening of financial conditions (particularly when considering only short-term interest rates).

7 Financial Conditions at the Zero Lower Bound

The preceding analysis assumes that policy rates can react to the economic weakness resulting from shocks to financial conditions (this is implicit in the impulse-response functions). However, currently in the United States, policy rates are at the zero lower bound, which implies that they can no longer be lowered to provide additional stimulus to the economy. Although other policy measures have been implemented recently, including the creation of several new credit facilities,

21. Guichard and Turner (2008) use an average over 4–6 quarters. We find that using this time horizon would yield very similar results. We also tested for a later average of 6–8 quarters, and again the results were robust to this time horizon, since most shocks had levelled out.

these measures may not be as effective in stimulating economic activity as would a cut in policy rates. Therefore, the impact that a tightening of financial conditions has on GDP is greater: negative financial shocks tend to lower inflation, but with nominal policy rates at the lower bound and the "desired policy rate" (as would be predicted by a standard Taylor rule) well below the lower bound, this would result in (*ceteris paribus*) higher real interest rates.

Although we cannot estimate the implications of constrained policy rates for the SFCI, because it would violate the Lucas critique, we can use our large-scale macroeconomic model to simulate the impact of a shock on GDP, if policy rates are left unchanged over the horizon used in the construction of the FCI (three years for the impulse-response functions).[22] This is not a problem in MUSE, since that model distinguishes between the role of expectations in the dynamic behaviour of variables from the role of other shocks; thus, agents' expectations adjust immediately to changes in the monetary policy regime. As Chart 13 shows, constrained policy rates have a large magnifying effect on the impact of shocks on GDP. In particular, the impact on the level of GDP from a shock to financial conditions (positive or negative) when the policy rate is at the binding lower bound is about 40 per cent larger than in normal circumstances.

Using impulse-response functions starting in 2008Q4 (when the Federal Reserve set rates at the lower bound) leads to a much larger estimated impact on GDP from the tightening of financial conditions. As Chart 14 shows, owing to the effect of the lower bound, the tightening of financial conditions subtracted around 5 per cent from GDP growth in 2008Q4 and 2009Q1.[23] The lower bound may also cause financial conditions to have a greater drag on economic growth going forward, since nominal interest rates are likely to remain at the lower bound for some time. In particular, past shocks to financial conditions may subtract up to 4.8 per cent from economic growth in 2009Q2, which is about 1.5 percentage points more than in the baseline MFCI. However, the fiscal stimulus and the large range of non-traditional policies put in place by the Treasury and the Federal Reserve should offset, at least in part, the negative contribution from financial conditions.

8 Conclusion

We have developed two growth-based FCIs in an attempt to quantity the effect of financial shocks on real activity, and have shown that tightening financial conditions have significantly dampened growth in the current cycle. In particular, our MFCI adjusted for the binding lower bound suggests that financial factors subtracted around 5 percentage points from quarterly annualized growth in 2008Q4 and 2009Q1. Moreover, in order to assess the effect of financial shocks in terms of policy interest rate equivalent units, we have converted the effect of financial

22. If this exercise were completed in the VAR, the Lucas critique would be violated, given that all equations in the VAR are estimated simultaneously. Therefore, changing the monetary regime would violate the Lucas critique, since we would be estimating a different model.
23. This finding is contingent on the duration of policy rates at the lower bound. If policy rates were to remain at the lower bound for a shorter (longer) period of time, the increased effect of financial shocks on economic activity would fall (rise).

developments on growth into the number of basis points by which the federal funds rate has been tightened. The results suggest that the net tightening of financial conditions since mid-2007 is equivalent to about 300 basis points of tightening in terms of the federal funds rate, despite the actual 500 basis point decline in the policy rate. Given the ongoing disruptions in financial markets, the degree of tightening of price and non-price credit conditions and the substantial losses in wealth over 2008, and the long transmission lags between a shock to financial conditions and its impact on the real economy, these financial conditions are expected to continue to dampen growth going forward. Finally, a key contribution of this paper has been to address the effect of financial shocks on real activity in the context of the zero lower bound on policy rates, as in the current crisis. The results suggest that the impact of financial shocks on the real economy may be amplified in the face of higher real interest rates, since policy interest rates are currently at the zero lower bound and credit and quantitative easing policies may not be as efficient in stimulating demand as traditional interest rate policies. Going forward, actions implemented by the Federal Reserve and the Treasury should help to improve the functioning of distressed markets, thereby removing a source of downward pressure on growth.

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Chart 1: Response of GDP to Financial Shocks (SVECM)

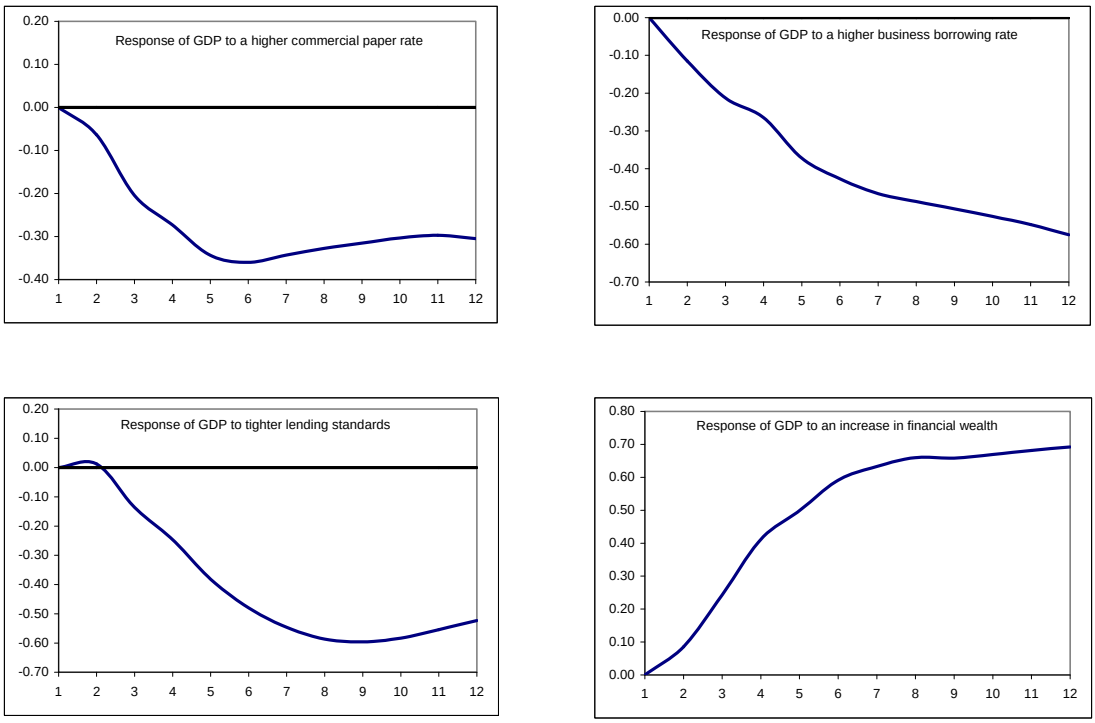


Chart 2: SVECM FCI

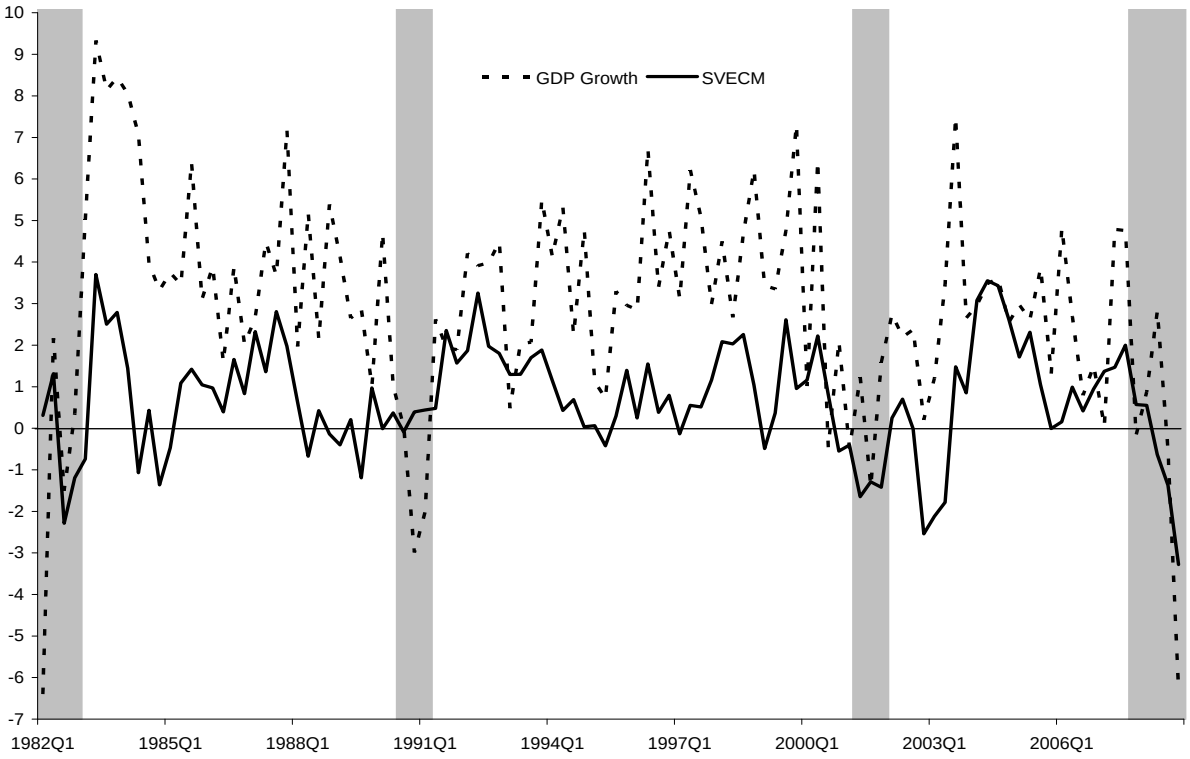
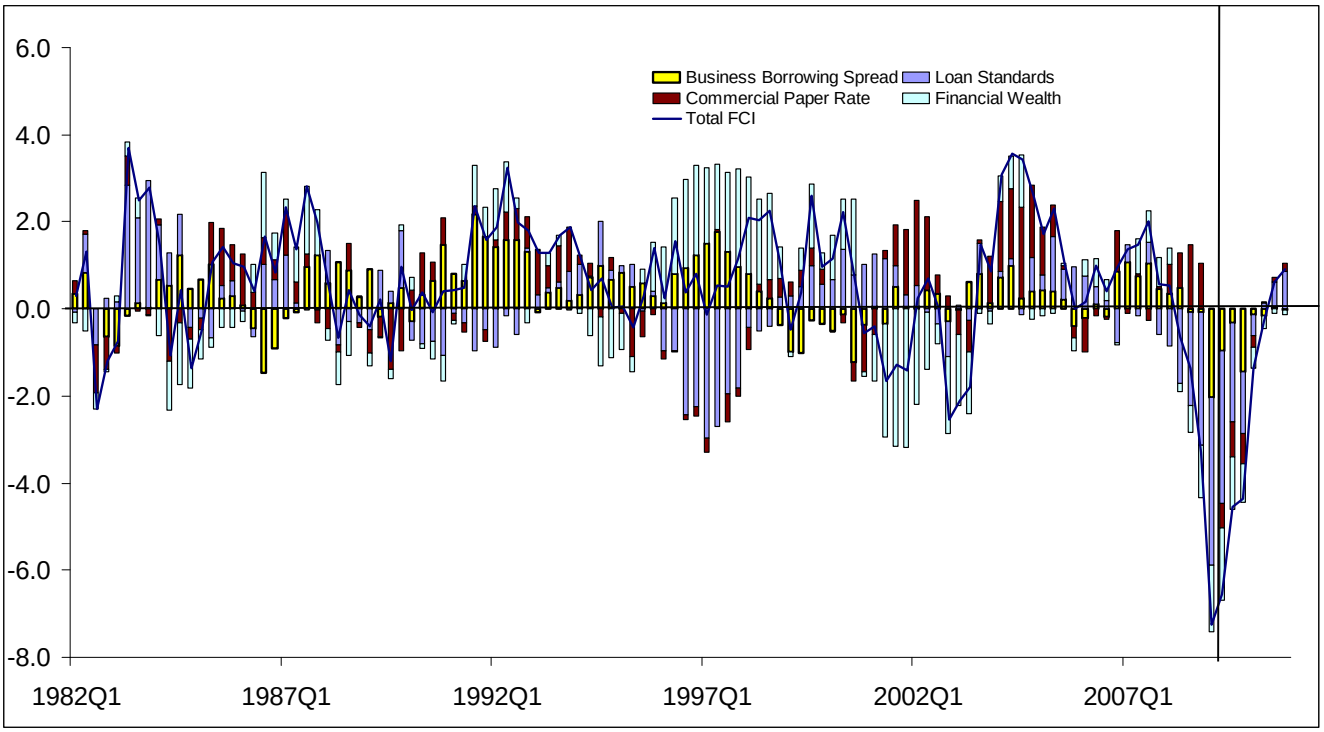


Chart 3: Total SVECM FCI Disaggregated by Component



Note: The vertical line represents the end of history: 2009Q1.

Chart 4: Response of GDP to Financial Shocks (MUSE)

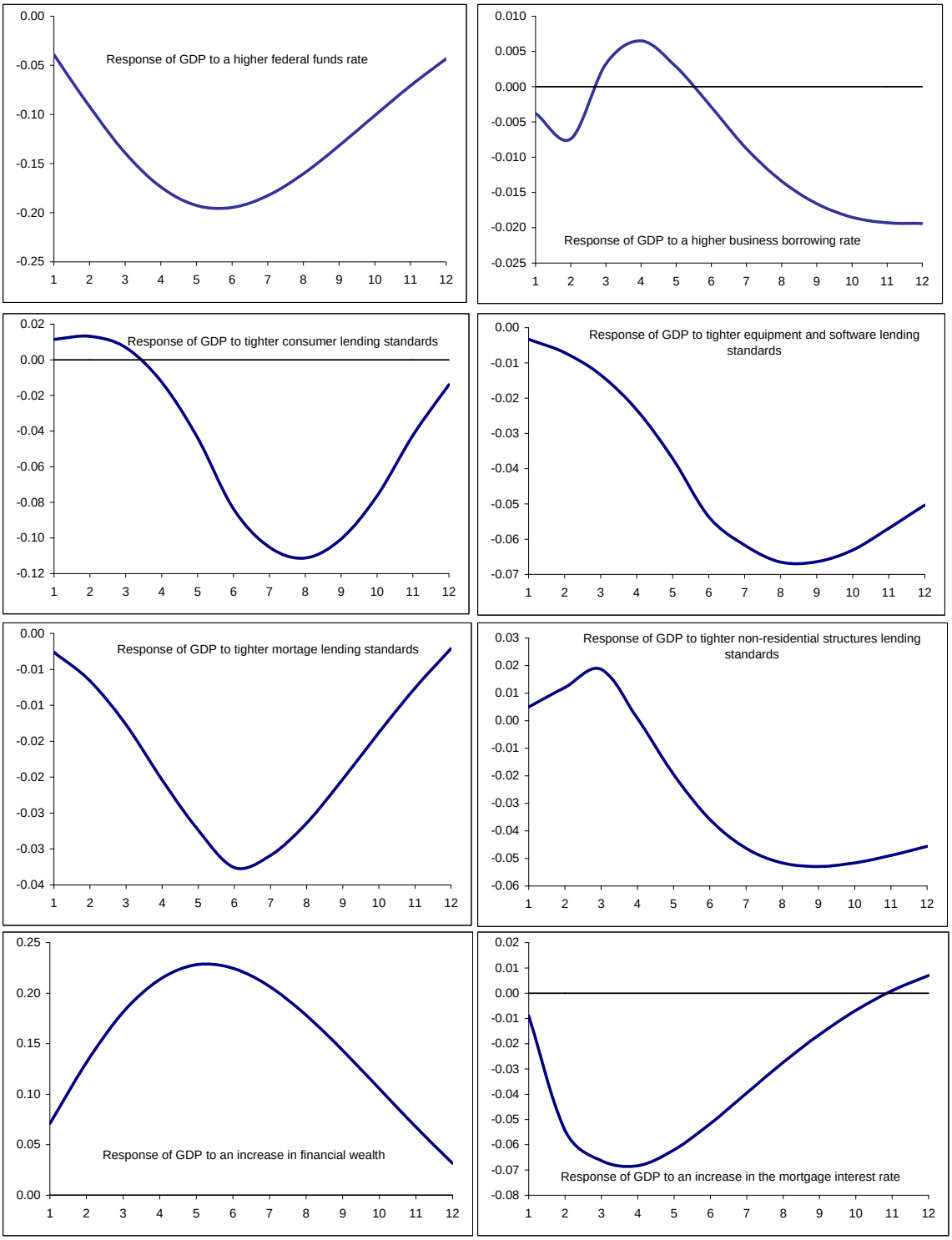


Chart 5: MUSE FCI

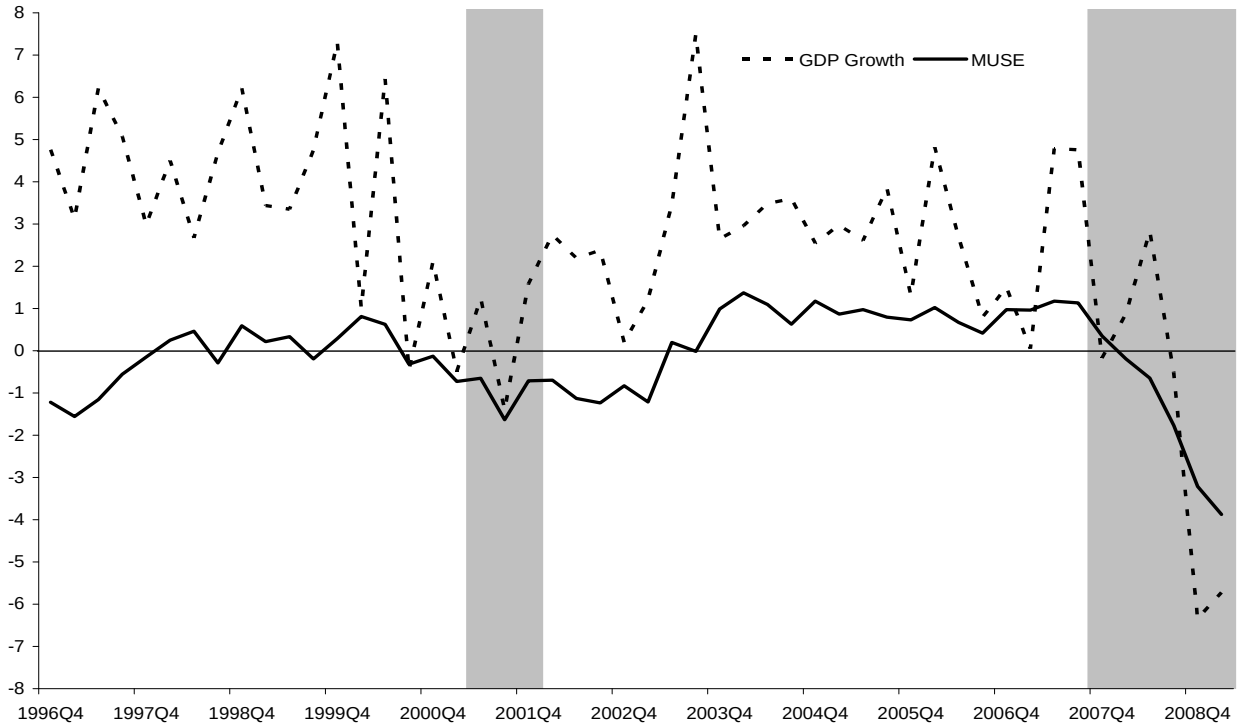


Chart 6: MUSE FCI Disaggregated by Component

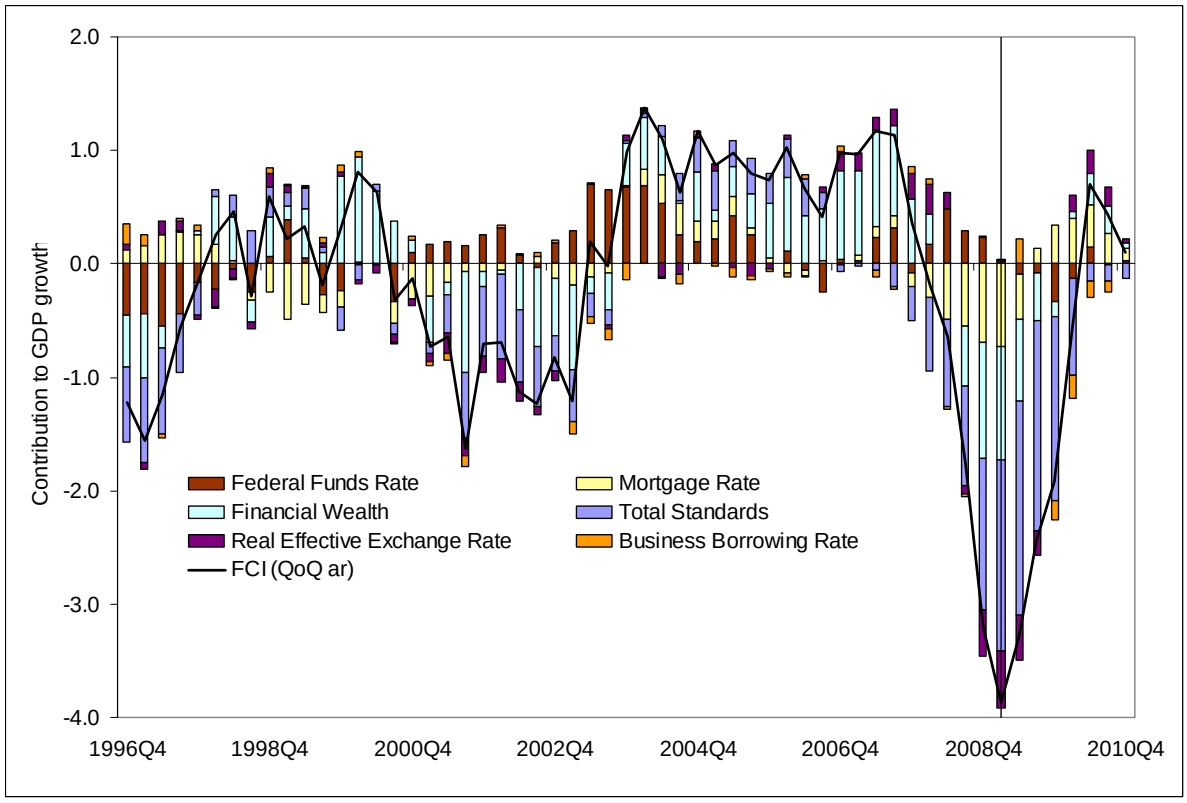


Chart 7: Lending Standards in the MUSE FCI

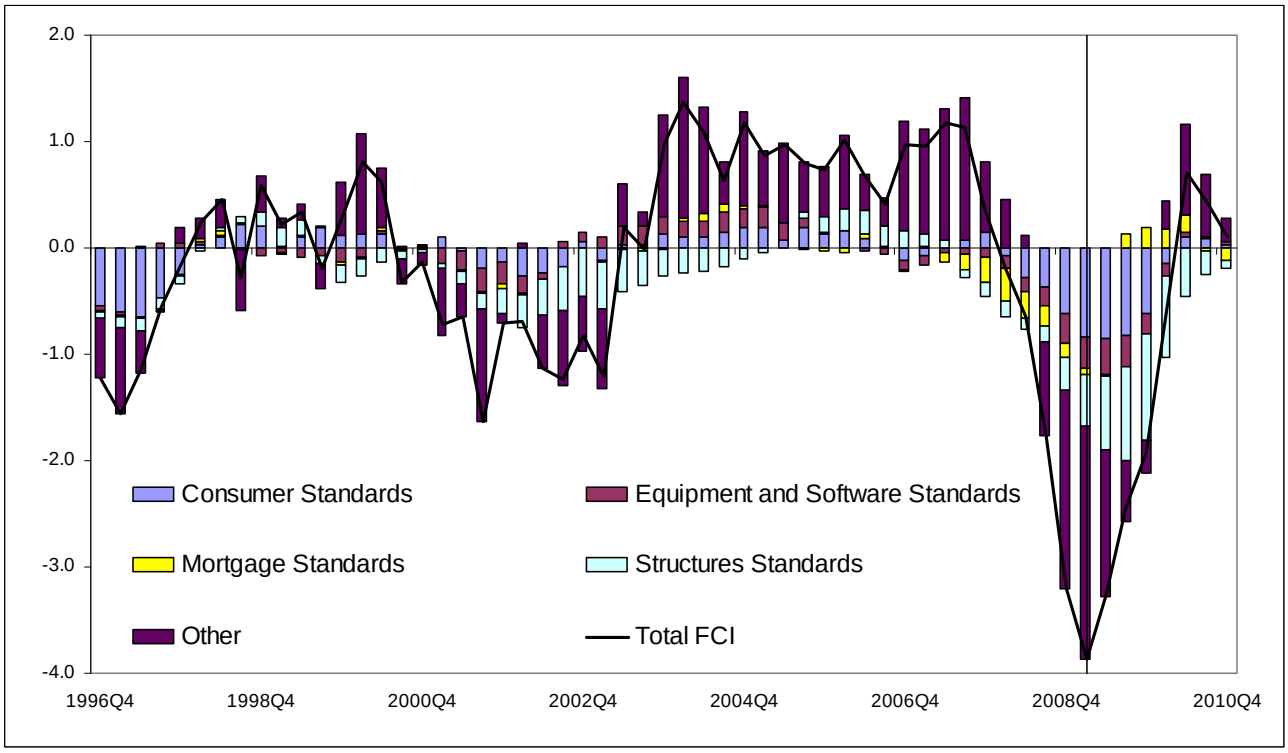


Chart 8: A Comparison of the Alternative FCIs

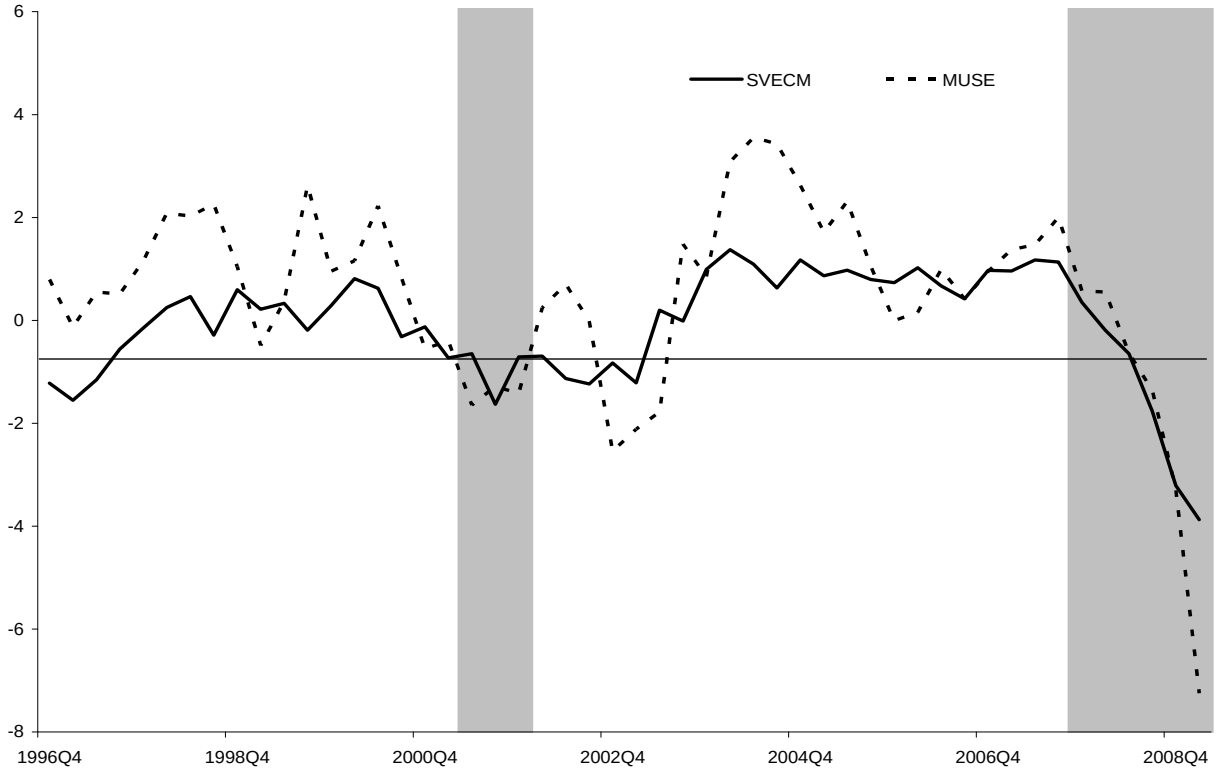


Chart 9: MUSE FCI Incorporating Housing Wealth

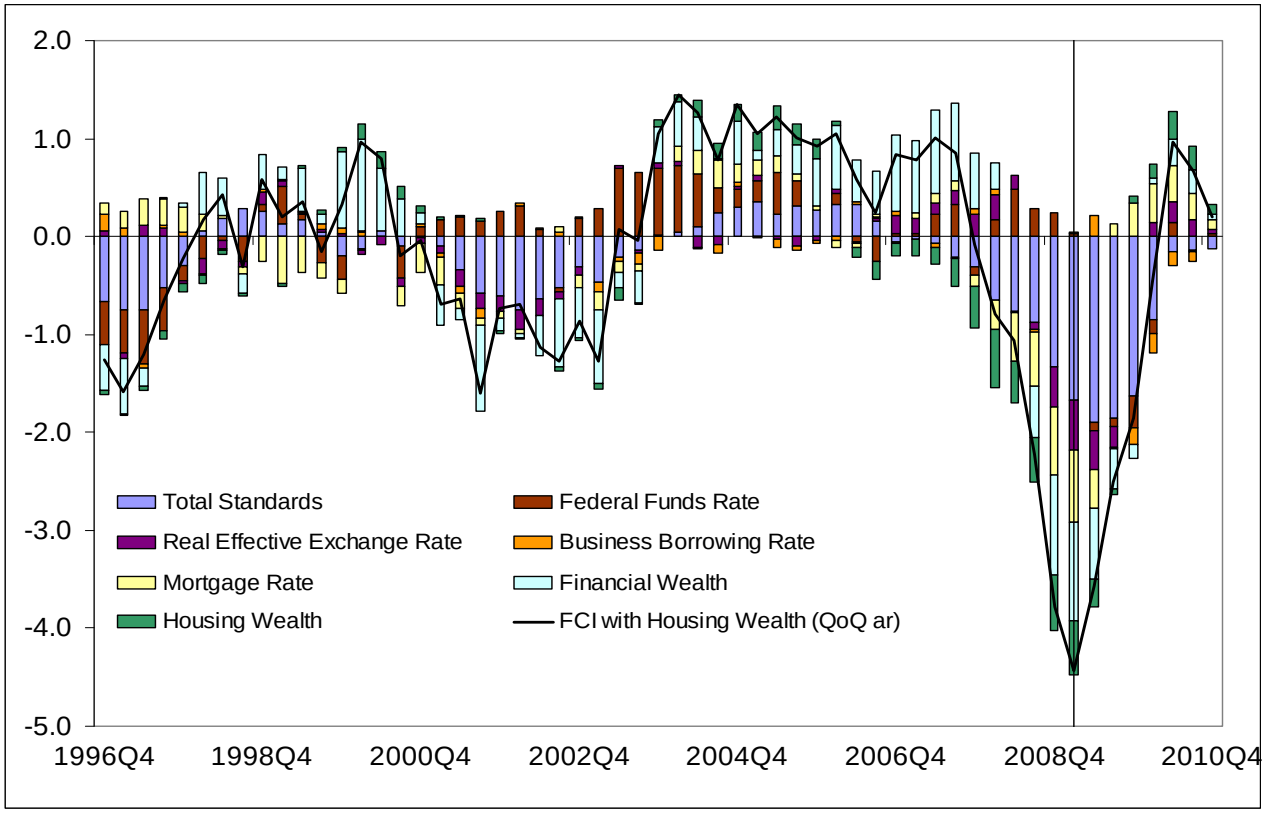


Chart 10: Effective Policy Rate FCI from MUSE

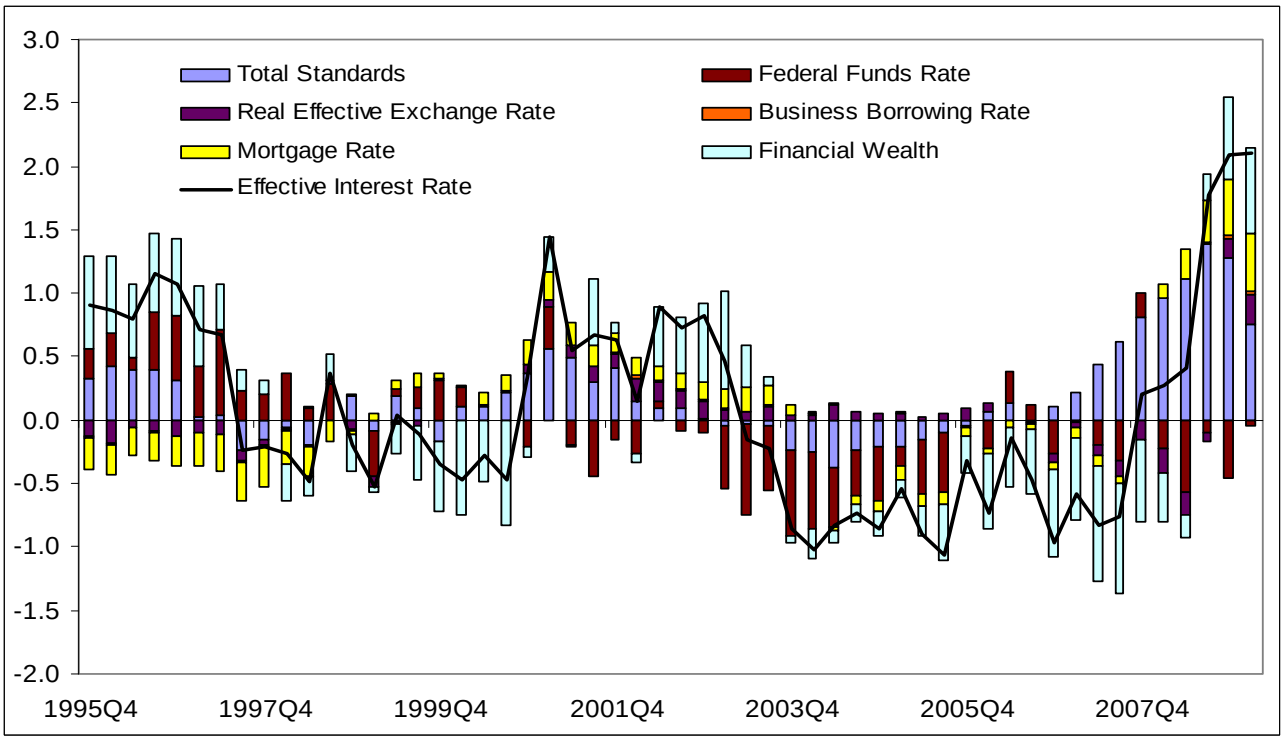


Chart 11: Effective Policy Rate FCI from SVECM

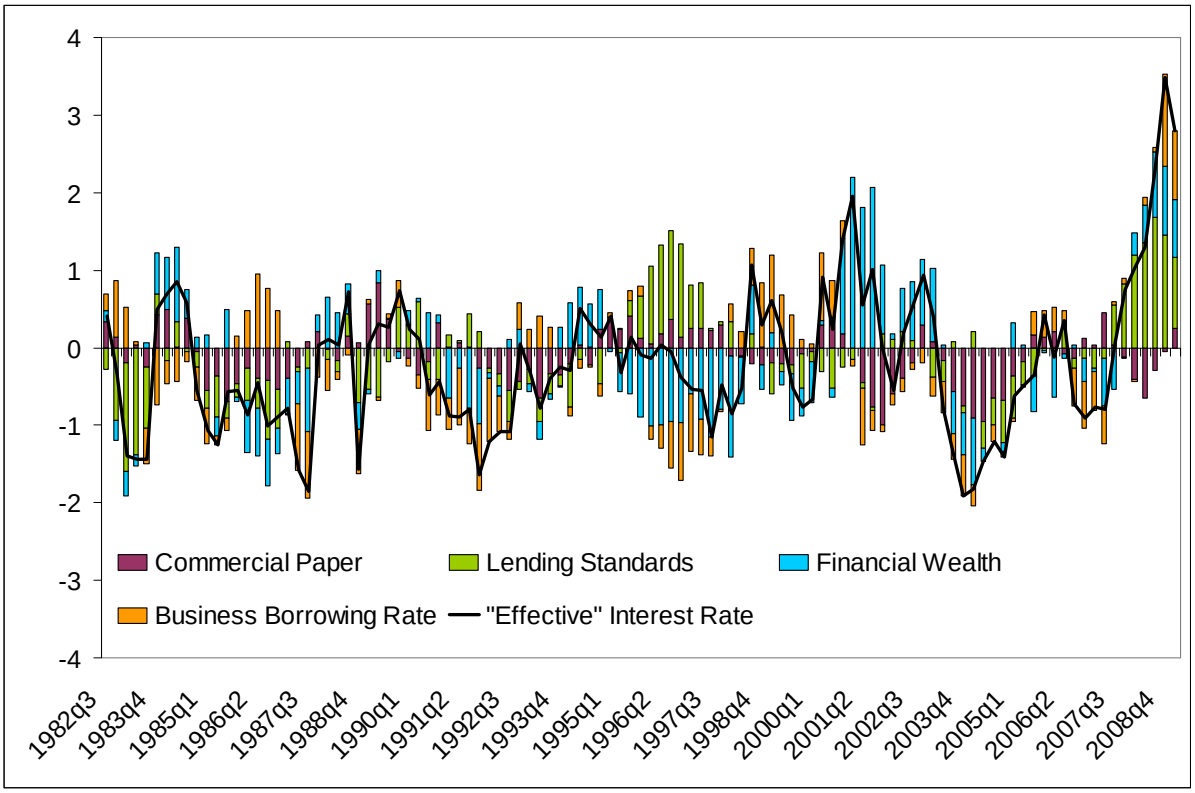


Chart 12: Effective Policy Rate FCIs

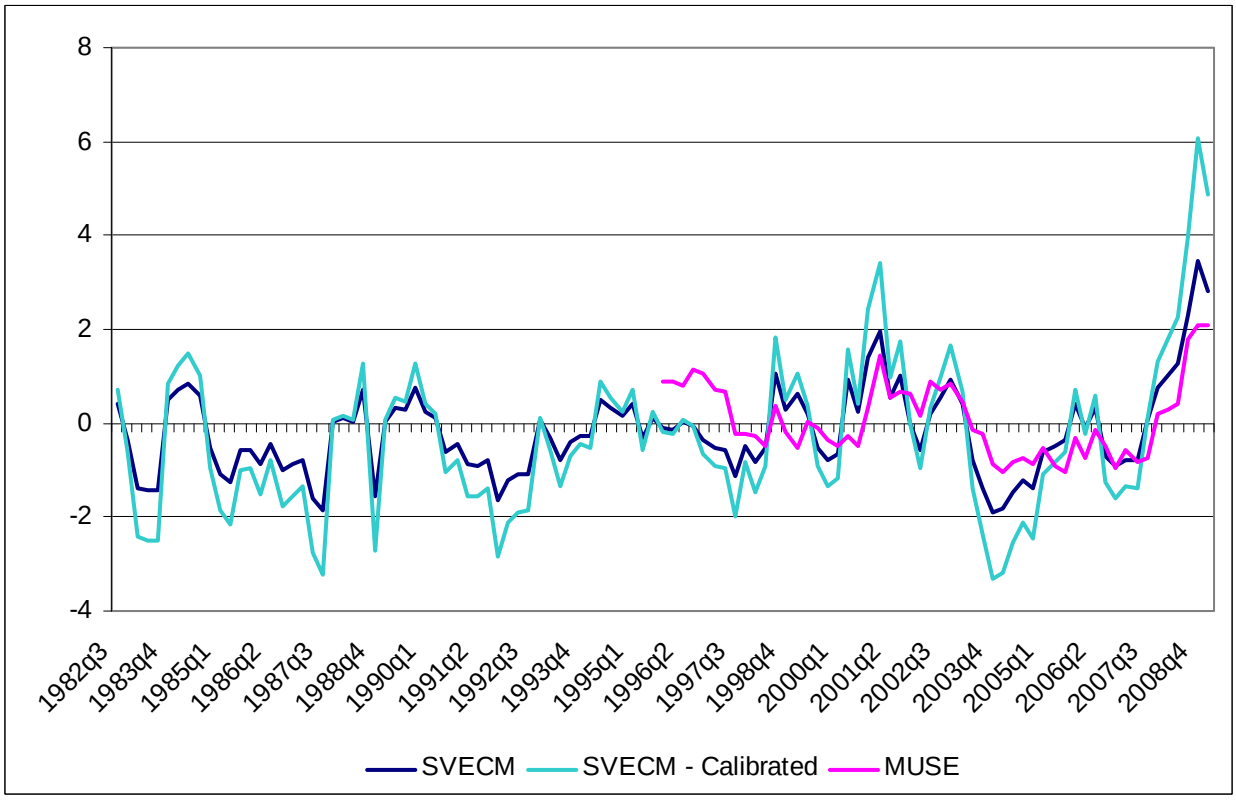


Chart 13: Response of GDP to Financial Shocks with the Lower Bound (MUSE)

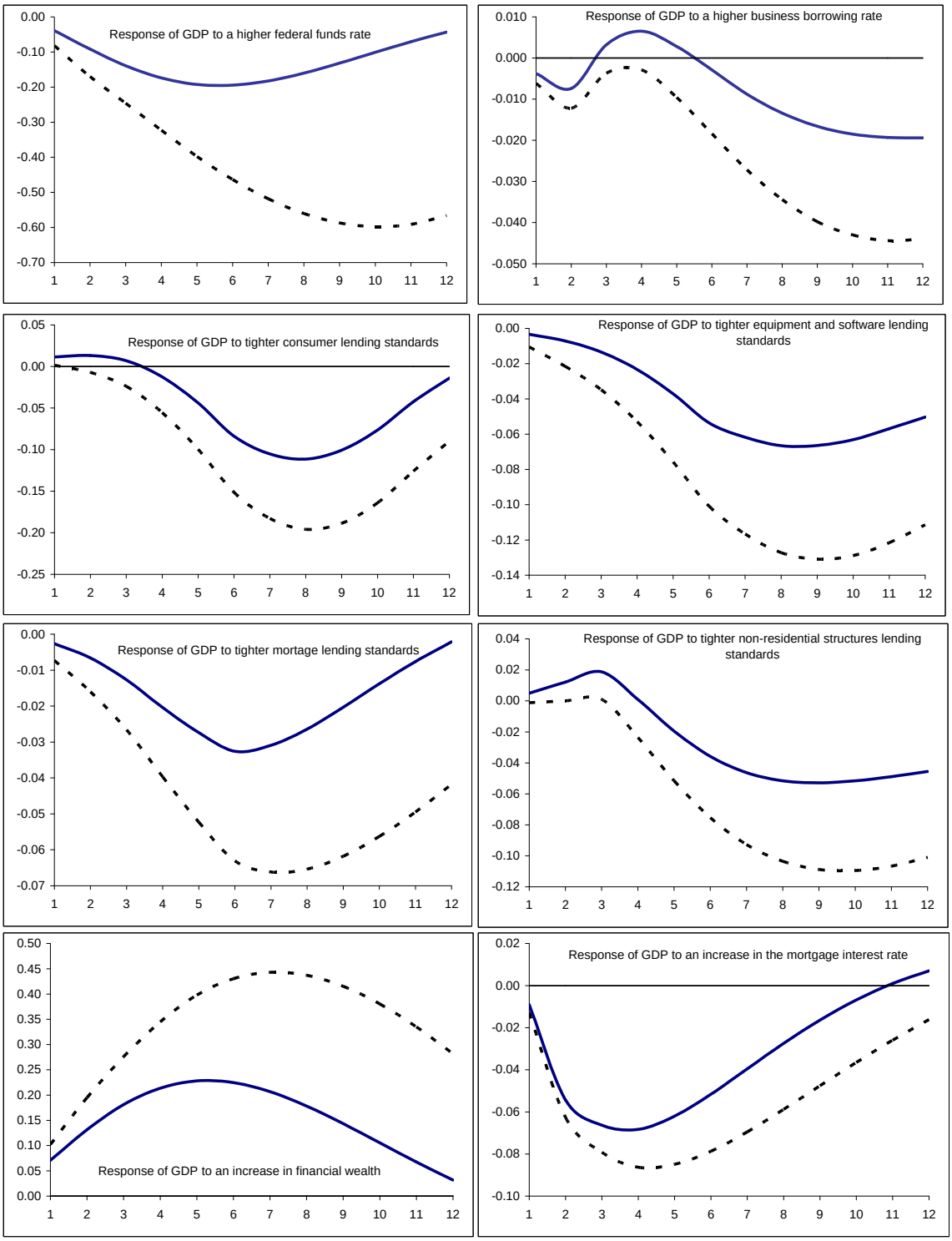
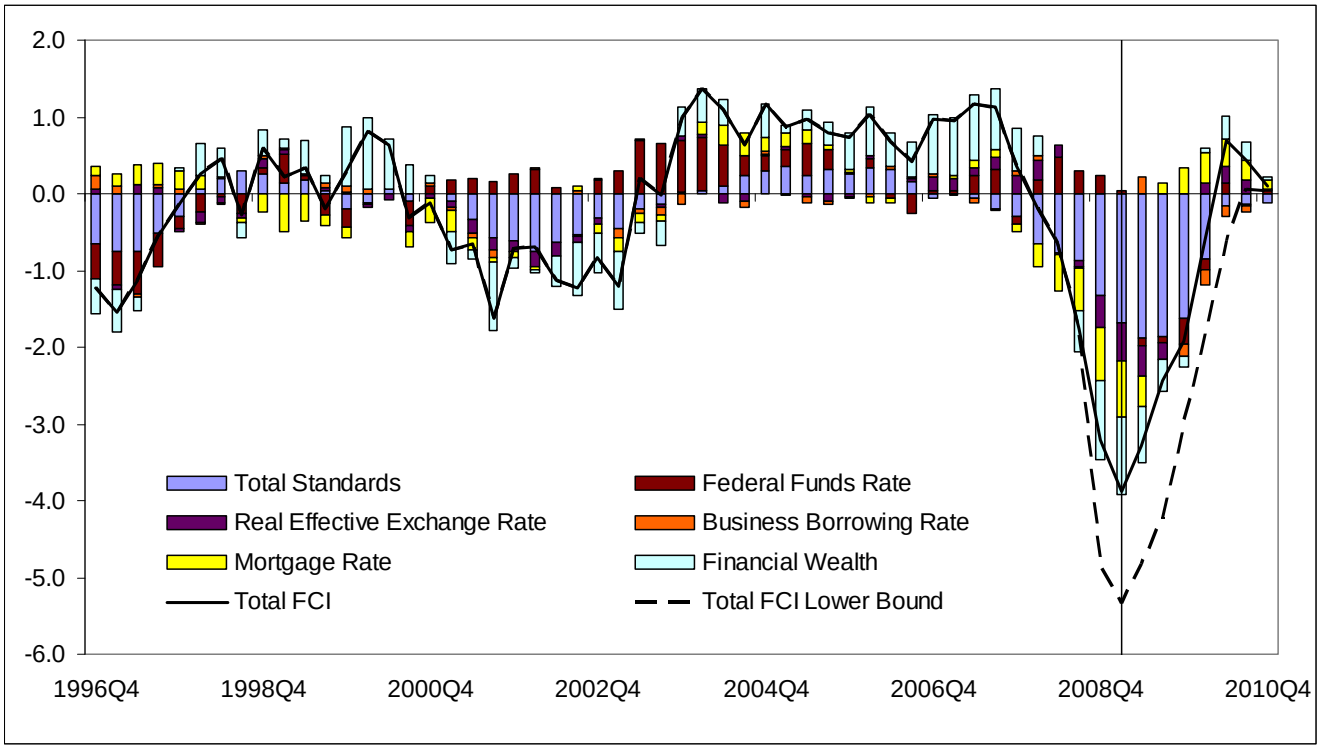


Chart 14: Effect of Zero Lower Bound on the MUSE FCI



Appendix A: Sources and Definitions of Variables

SFCI

- Real GDP - Change in the log of real GDP (U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts).
- Inflation – Change in the log of the GDP deflator (U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts).
- Real commercial paper rate – 3-month financial paper rate (Federal Reserve Board, Selected Interest Rates (H15)) deflated by core PCE (U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts).
- Business borrowing spread – Yield on Moody's BAA corporate bonds (Federal Reserve Board, Selected Interest Rates (H15)) deflated by the GDP deflator less the yield on Treasury securities of a constant maturity of 10 years (Federal Reserve Board, Selected Interest Rates (H15)) deflated by the GDP deflator.
- Lending standards for consumer spending – Prior to 1996Q1 - One minus the share of domestic banks more willing to make consumer instalment loans (Federal Reserve Board, Senior Loan Officer Survey on Bank Lending Practices). Post 1996Q1 - Change in the net percentage of respondents indicating tightening loan standards for consumer credit (Federal Reserve Board, Senior Loan Officer Survey on Bank Lending Practices).
- Real Financial Wealth – Net acquisition of financial assets (Federal Reserve Board, Flow of Funds) less net increase in liabilities (Federal Reserve Board, Flow of Funds) net of home mortgage liabilities (Federal Reserve Board, Flow of Funds). Deflated by the GDP deflator.

MFCI

- Real federal funds rate – Federal funds rate (Federal Reserve Board) deflated by core PCE.
- Real business borrowing rate – Yield on Moody's BAA corporate bonds deflated by the GDP deflator.
- Real mortgage interest rate – Conventional 30-year mortgage rate (Federal Reserve Board, Selected Interest Rates (H15)) deflated by the GDP deflator.
- Real effective exchange rate – Price adjusted broad U.S. dollar foreign exchange value (Federal Reserve Board).
- Lending standards for consumer spending – Weighted 9-quarter moving average of: prior to 1996Q1 - one minus the share of domestic banks more willing to make consumer instalment loans, post 1996Q1 - change in the net percentage of respondents indicating tightening loan standards for consumer credit.
- Lending standards for business investment in equipment and software – Weighted 9-quarter moving average of the net percentage of respondents indicating tightening loan standards for commercial and industrial loans to large and medium-sized firms (Federal Reserve Board, Senior Loan Officer Survey on Bank Lending Practices).
- Lending standards for business investment in structures – Net percentage of respondents indicating tightening standards for commercial real estate loans (Federal Reserve Board, Senior Loan Officer Survey on Bank Lending Practices).
- Lending standards or mortgages – Weighted 6-quarter moving average of the net percentage of respondents indicating tightening loan standards for mortgages to individuals (Federal Reserve Board, Senior Loan Officer Survey on Bank Lending Practices).
- Real Financial Wealth – Net acquisition of financial assets less the net increase in liabilities net of home mortgage liabilities. Deflated by the GDP deflator.