Financial Stress, Monetary Policy, and Economic Activity

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- *The recent global crisis is a prime example of the substantial impact that periods of high financial sector stress can have on the real economy. Indeed, this crisis clearly demonstrates that the real economy and the financial sector can undermine each other, with financial stress and weak output feeding each other.*
- *This article examines the potential for non-linear relationships between financial stress, monetary policy, and the real economy by surveying the relevant literature and estimating a model with Canadian data.*
- *The research summarized indicates that the economy can be characterized by regimes of low and high financial stress and that monetary policy can influence the likelihood of transitioning between the two regimes.*
- *It also implies that monetary policy actions have stronger effects when financial stress is high and that tightening monetary policy tends to have more impact than easing.*

Although there have been various episodes of high financial stress (e.g., the recession of the early 1980s, the Asian crisis of the 1990s, the 1998 LTCM scare, and the high-tech bust of the early 2000s), the recent crisis has been remarkable for the intensity of the negative feedback process between financial sector developments and the real economy that characterized it. Policy-makers had to take exceptional measures to break this process, in particular, reducing interest rates to historic lows. While policy actions were successful at reducing financial stress, the crisis nevertheless stimulated interest in the relationship between financial sector developments, the real economy, and monetary policy. This article briefly reviews the economic literature on this topic, focusing on studies that allow for non-linear relationships between monetary policy, financial stress, and the real economy.

Results obtained from an empirical model estimated with Canadian data and allowing for the presence of two financial-stress regimes are also presented. The methodology used builds upon Balke (2000), and financial stress is measured with the index proposed by Illing and Liu (2006), which was designed to reflect tensions in the Canadian financial system.

Selective Literature Review

Seminal contributions by economists as diverse as Knut Wicksell, Irving Fisher, and Friedrich von Hayek have emphasized the role that financial sector developments play in explaining economic fluctuations.[1] More recent contributions have examined the potential for non-linear or amplifying relationships between financial stress, monetary policy, and other economic variables (i.e., the relationship between these variables may not be proportional).

1 See Laidler (2007) for an excellent discussion.

For example, Blinder (1987) presents a theoretical model with credit frictions (imperfect information about borrowers) in which the economy can enter credit-rationing regimes in which some creditworthy borrowers cannot access credit. This could be caused by tight monetary policy, which Blinder defines as a decrease in central bank reserves. Output growth is lower in such a regime, since a tighter monetary policy can imply that businesses lose access to credit, amplifying non-linearly the effects of the monetary policy tightening (over and above more traditional effects on investment and consumption).[2]

Bernanke and Gertler (1989) present a model with agency costs in which changes in borrowers' balance sheets can give rise to a "financial accelerator" amplifying fluctuations in output. In their model, negative exogenous "technology" and "balance-sheet" shocks are likely to have a greater effect than positive shocks, because financing constraints likely become binding only after a certain level of borrowing. Subsequent work extended this analysis to models that include monetary policy. For instance, Bernanke and Gertler (1995) discuss models in which the effects of monetary policy shocks on real spending can be magnified through a higher premium on external financing (the cost of financing a project through borrowing minus that of using internal funds). They also discuss a bank-lending channel through which a bank's financial situation also acts as an accelerator mechanism. More recently, Adrian and Shin (2009) argue that the effects of monetary policy can be amplified through impacts on the balance sheets of other types of financial intermediaries.[3]

Even though these models differ in various dimensions, they all imply non-linear dynamics between financial stress, monetary policy, and the real economy, and they provide a theoretical rationale for empirical analyses of non-linear and regime-dependent relationships between the degree of financial stress, monetary policy, and economic activity.

One example of such an exercise is McCallum (1991). He uses U.S. data to estimate a simple output equation in which the coefficient associated with the monetary variable (M1 in one version) changes when the economy is thought to be in a regime of credit rationing. He finds that monetary tightening has stronger effects (output slows more) when credit is tight, a result that he says corroborates a prediction of Blinder's (1987) model.

Like McCallum, Galbraith (1996) uses a single-equation model. However, while in McCallum's work credit regimes are determined exogenously, Galbraith's model allows for endogenously determined threshold effects (i.e., the economy can be in different credit regimes with different economic relationships). He finds evidence of such effects for the United States but not for Canada. The absence of a credit variable in Galbraith's model might explain his mixed results.

Since the empirical exercise presented in this article builds largely on Balke (2000), we discuss his approach in more detail. It consists of (i) selecting and estimating a four-variable threshold vector autoregressive (TVAR) model with U.S. economic data; (ii) testing formally for the presence of threshold effects; and (iii) analyzing impulse responses to see if they reveal signs of non-linear propagation of shocks across the regimes identified by the threshold model. Balke uses the yield spread between commercial paper and Treasury Bills to identify credit regimes. The other variables included in his TVAR model are real output, inflation, and a monetary variable (approximated by M2 growth or the federal funds rate). Balke finds strong evidence of threshold effects related to credit conditions. He also finds that, on average, tightening monetary policy (a higher interest rate or slower growth rate of money) has larger effects than easing.[4] In addition, he finds that monetary shocks have larger effects in the tight-credit regime.

Various studies have used approaches similar to that of Balke. For example, Atanasova (2003) finds significant evidence of threshold effects with models applied to U.K. data. In addition, she finds that monetary policy has a greater impact when credit is tighter. However, she also finds that the effects of positive and negative monetary policy shocks are symmetric.

It is important to note that most of the studies mentioned use market-specific measures of financial stress. For instance, Balke focuses on the commercial paper market, ignoring potential stresses in other markets. To address this limitation, the empirical exercise presented here uses a financial stress index (FSI) designed to reflect tensions in various Canadian credit markets.

2 Azariadis and Smith (1998) also present a model with endogenously determined credit-rationing regimes.

3 The "financial accelerator" ideas popularized by Bernanke and Gertler have generated a large literature that Bernanke (2007) summarizes in non-technical terms. There have been attempts to integrate these ideas in policy models; for example, Christensen et al. (2009).

4 A related literature, using different approaches, generally reaches the same conclusion: monetary tightening has a stronger impact than monetary easing. See, for instance, Cover (1992) and Karras (1996). In contrast, Weise (1999) finds that the effects are symmetric.

The Model

Within the class of possible non-linear models, we concentrate on the TVAR model. Such a model provides a relatively simple and intuitive way to formulate non-linearity, such as regime switching, asymmetry, and multiple equilibriums, implied by the theoretical models of financial and macroeconomic activity. A TVAR model works by splitting time series endogenously into different regimes. The role of financial-stress conditions as a non-linear propagator of shocks is captured by a TVAR model containing four variables: Canadian real output growth, inflation, the real overnight rate, and a financial stress index. Although the FSI is the chosen threshold variable, because all the variables included in the model are endogenous, shocks to output, inflation, the overnight rate, and to financial-stress conditions may induce a shift to a different financial-stress regime.[5]

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In addition, we assume that the TVAR model has a recursive structure, with the causal ordering as follows: output growth, inflation, the real overnight rate, and the financial-stress variable. This ordering implies that monetary policy shocks are shocks to short-term interest rates and do not have a contemporaneous impact on output or inflation. This is consistent with the view that monetary policy shocks affect output and inflation only after a lag. Monetary policy shocks can, however, have a contemporaneous impact on the FSI. This assumption reflects the view that financial variables can respond very quickly to all types of shocks.[6]

Financial stress is measured using the index for Canada proposed by Illing and Liu (2006). The index is a continuous variable composed of various measures of tension in credit markets. The variables in the FSI are selected based on a literature review and are weighted by the relative size of the market to which they pertain in Canadian total credit. This weighting approach produced an index that could fit episodes of financial stress identified in a survey of Bank of Canada senior managers and economists. It is important to note that movements in the FSI could be caused by shocks originating outside Canada. This is because foreign developments can affect Canadian variables captured by the FSI and because the FSI includes foreign economic variables, such as volatility in the Can$/US$ exchange rate and the spread between Canadian and U.S. short-term borrowing rates.[7]

Results

The sample period is 1981Q4 to 2009Q4.[8] All series are quarterly. **Chart 1** presents the time series for the growth rate of real GDP, inflation, the real overnight rate, and the FSI—the threshold variable. For reference, periods with significant economic events are shaded. **Table 1** presents tests of a linear VAR model against a TVAR alternative, as well as the estimated threshold values for the FSI. The test results in **Table 1** provide strong evidence against linearity in the VAR model and in favour of the TVAR specification. Whether this non-linearity results in economically meaningful asymmetry in the effects of monetary policy shocks, however, must be determined by examining the dynamic effects of these shocks in the TVAR model.

Table 1: Tests for threshold VAR

Threshold variable	Threshold value	Sup-Wald statistic	Exp-Wald statistic	P-value
FSI	50.58	134.32	63.85	0.00

Note: The delay for the threshold variable is given by d =1, and the lag of the TVAR is 3. The p-values are calculated by Hansen's (1996) bootstrap method with 500 replications.

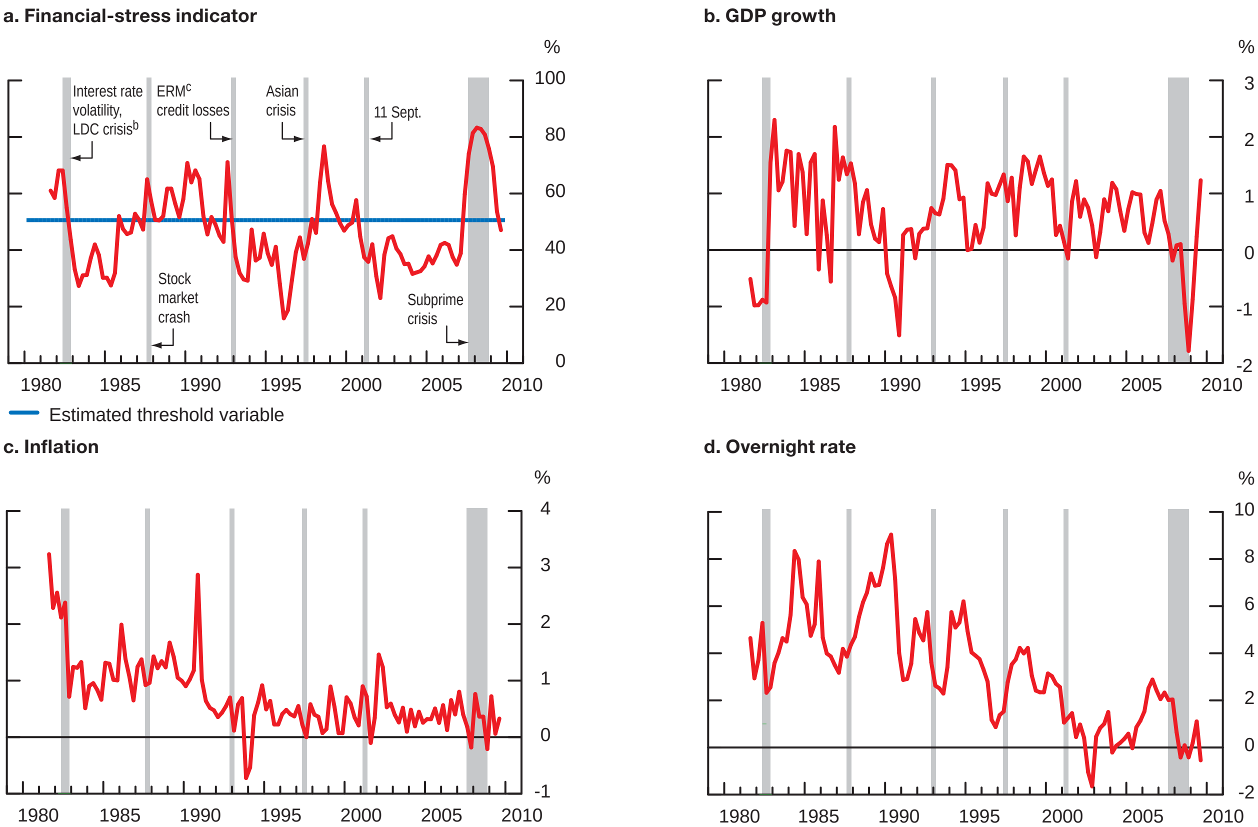
5 See Li and St-Amant (2010) for more details about the methodology.

6 Balke (2000) and Atanasova (2003) use similar assumptions, as do various other empirical models of monetary policy.

7 The index also includes the following variables: the spread between yields on bonds issued by Canadian financial institutions and the yields on government bonds of comparable duration; the yield spread on Canadian non-financial corporate bonds; the inverted term spread (i.e., the 90-day treasury bill rate minus the 10-year government yield); the beta derived from the total return index for Canadian financial institutions; TSX GARCH volatility; the average bid/ask spread on Canadian treasury bills; and the spread between Canadian commercial paper rates and rates on treasury bills of comparable duration. See Illing and Liu (2006) for more details.

8 The sample used by Li and St-Amant (2010) is 1981Q4 to 2006Q4. In addition, total inflation is used in the working paper, instead of the core inflation measure used here. Most results are qualitatively the same, but the longer sample provides more evidence that monetary shocks have a larger impact on output when financial stress is high.

Chart 1: Variables used and estimated threshold value[a]



a. Shaded areas on each chart denote the events labelled in Chart 1a.
b. LCD: Less-developed country
c. ERM: Exchange rate mechanism
Source: Authors' calculations

The asymmetric effects of monetary policy shocks are explored along three dimensions.[9] First, does a contractionary policy shock (a higher real overnight rate than predicted by the model) have different effects than an expansionary policy shock? Second, do monetary policy shocks have different effects in regimes of low and high financial stress? Third, do shocks of different magnitudes have disproportionate effects?

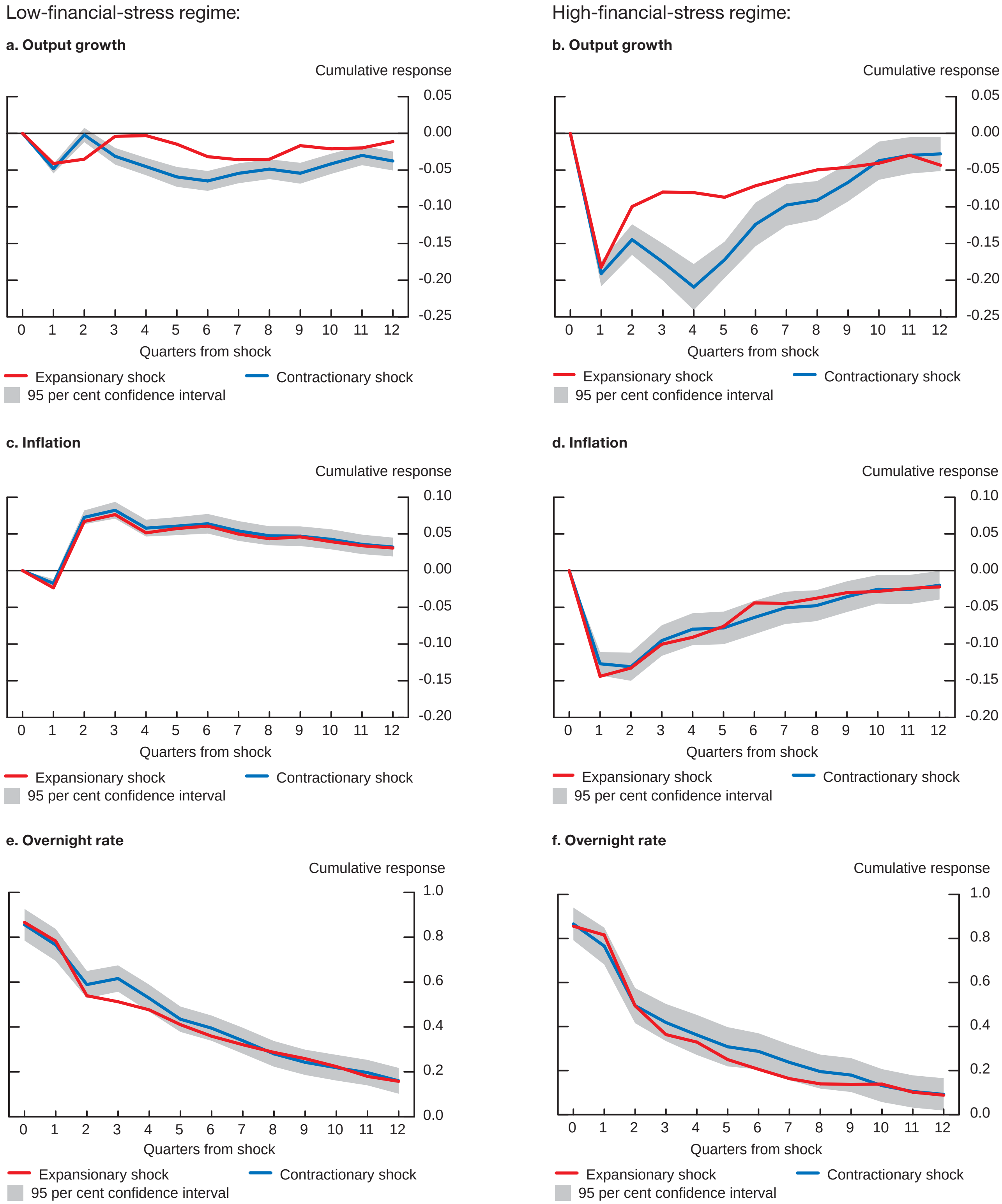
Chart 2 presents the estimated impulse response of our four variables over 12 quarters to a one-time shock to the real overnight rate in regimes of low and high financial stress. The size of the shock is set to the standard deviation of monetary policy shocks computed in the linear model. The responses to contractionary shocks, along with their 95 per cent pointwise confidence band (calculated with the bootstrap method) are plotted, as well as the responses to expansionary shocks with the sign reversed.

Regardless of the initial level of financial stress, a contractionary monetary shock has a stronger effect on output growth and the FSI than an expansionary shock.

Chart 2 provides some evidence of asymmetry in the effects of contractionary and expansionary monetary policy shocks on output growth and the FSI. This result indicates that regardless of the initial level of financial stress, a contractionary monetary shock has a stronger effect on output growth and the FSI than an expansionary shock. This asymmetric response of output growth is consistent with the results of McCallum (1991), Balke (2000), Cover (1992), and

9 Whereas in a linear model, one set of impulse-response functions is sufficient to characterize the estimated model, in the non-linear case, the impulse-response functions are sensitive to the initial conditions and to the magnitude of the impulses. Details on computing the impulse-response functions for a TVAR model are discussed in Atanasova (2003).

Chart 2: Response to monetary policy shocks in different financial-stress regimes

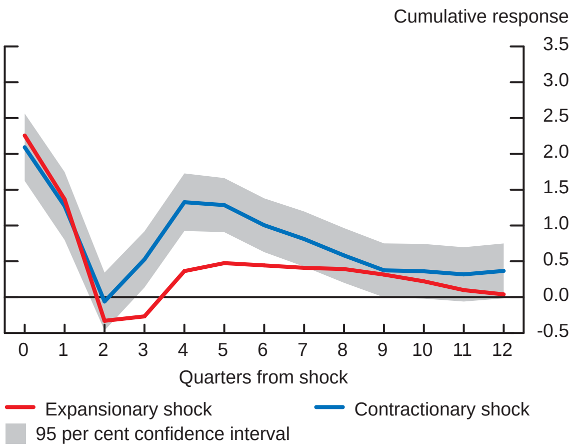


Source: Authors' calculations

Chart 2: Response to monetary policy shocks in different financial-stress regimes (cont'd)

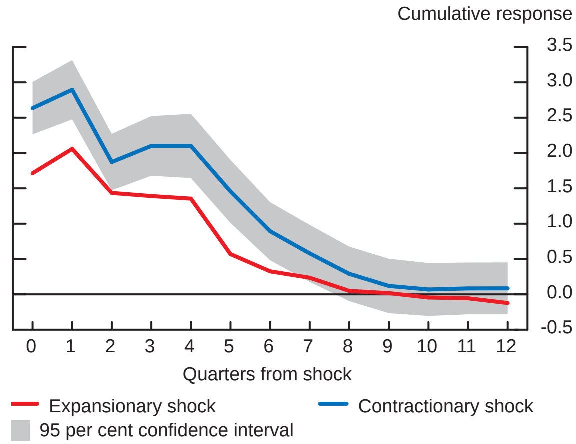
Low-financial-stress regime:

g. FSI



High-financial-stress regime:

h. FSI



Source: Authors' calculations

Karras (1996). However, it differs from those of Weise (1999) and Atanasova (2003).

Chart 2 also shows that, when the economy is in a regime of low financial stress, inflation begins to fall quickly in response to a contractionary policy shock, and the negative responses persist for a quarter, after which the responses are positive. To explore the possible reasons for the positive responses, **Table 2** reports the average values of the four variables in different financial regimes, indicating that, on average, in the high-financial-stress regime, inflation, the FSI, and the real overnight rate are higher, and output growth lower, than in the low-financial-stress regime.[10] Obviously, one of the most important features of the TVAR model is that shocks can cause regimes to change, suggesting that the impulse-response functions depend not only on the original state of the economy at the time of the shock, but also on the current state of the economy. We also find that when the economy is initially in a regime of low financial stress, a contractionary policy shock has a higher probability of switching the economy into a high-stress regime than the absence of a monetary policy shock **(Chart 4)**.

We find that when the economy is initially in a regime of low financial stress, a contractionary policy shock has a higher probability of switching the economy into a high-stress regime than the absence of a monetary policy shock.

Table 2: Mean values of variables in different regimes

Financial-stress regime	GDP growth rate	Inflation rate	Real overnight rate	FSI
Low stress	0.84	0.58	2.85	38.13
High stress	0.26	0.99	4.01	62.43

Chart 3 displays information similar to that in **Chart 2**, except that regimes of high and low financial stress are grouped together on the same chart instead of positive and negative shocks. This chart provides strong evidence to support the hypothesis that the effects of monetary policy shocks differ depending on the initial state of the economy. For instance, **Chart 3** shows that a contractionary shock to monetary policy causes more financial stress and a greater decrease in output growth when the economy is in high financial stress than when it is in low financial stress. Inflation also responds more strongly. According to Blinder's (1987) model of credit rationing, a tightening of monetary policy has stronger effects on the real

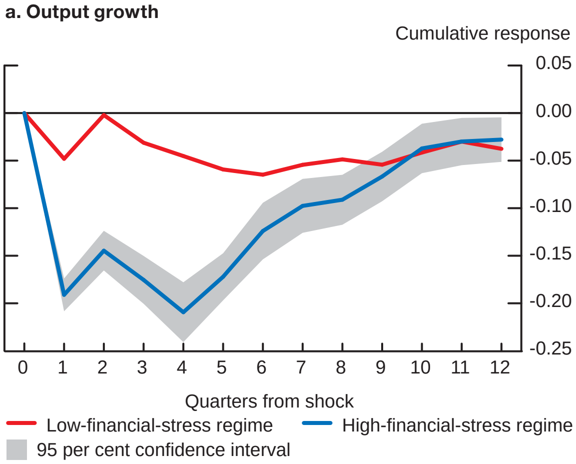
10 These are average values that do not need to repeat themselves in the future. For instance, the ongoing global financial crisis appears to be associated with disinflation, not inflation.

Chart 3: Response in different financial-stress regimes experiencing a contractionary or expansionary shock to monetary policy

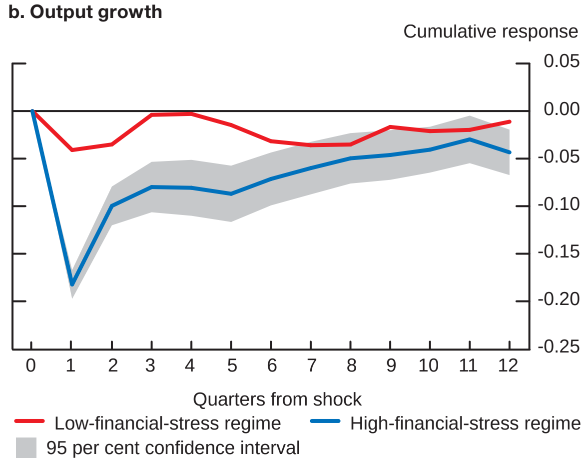
Contractionary shock:

Expansionary shock:

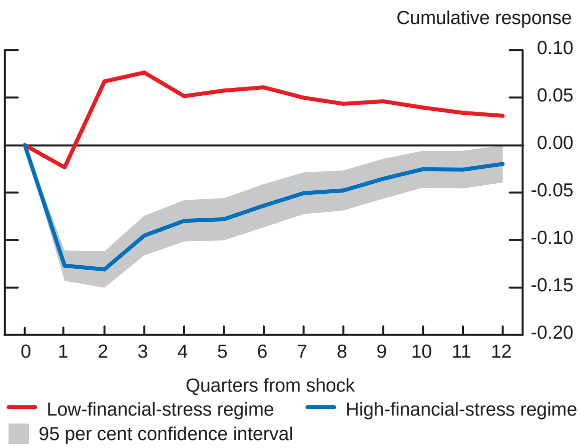
a. Output growth



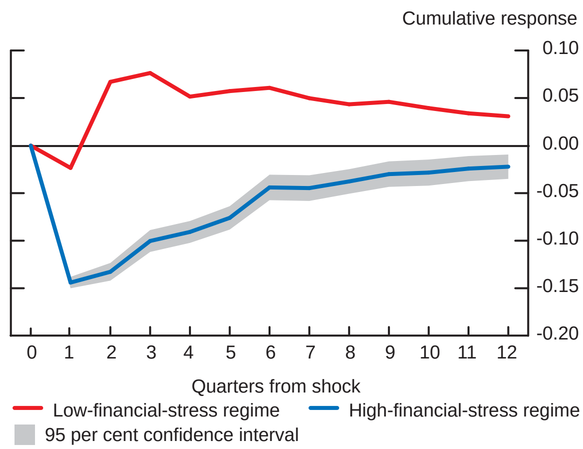
b. Output growth



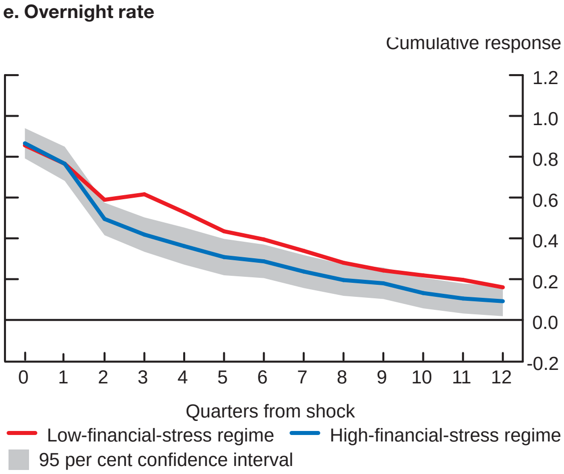
c. Inflation



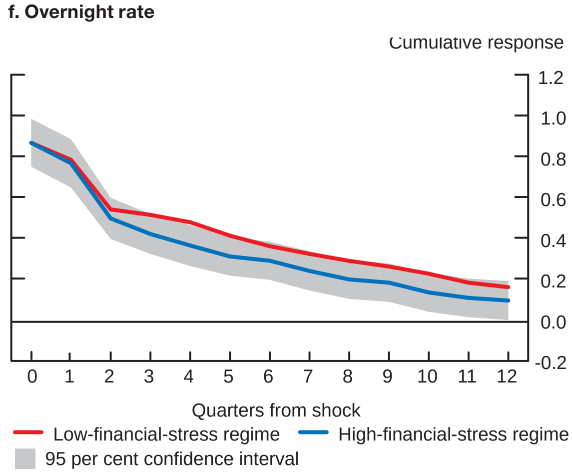
d. Inflation



e. Overnight rate



f. Overnight rate

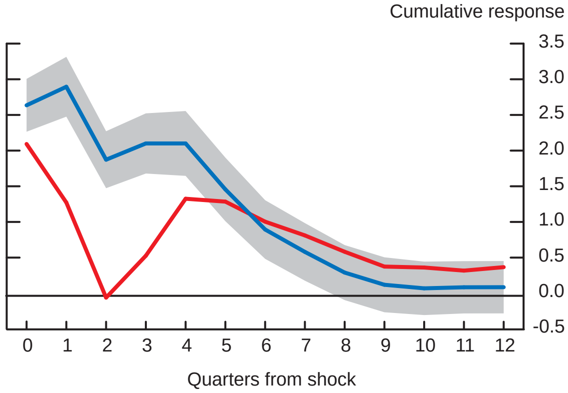


Source: Authors' calculations

Chart 3: Response in different financial-stress regimes experiencing a contractionary or expansionary shock to monetary policy (cont'd)

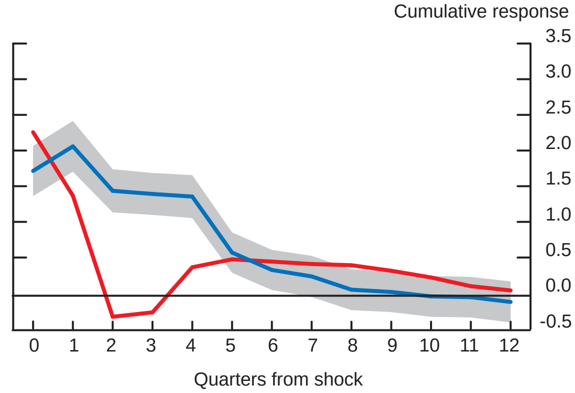
Contractionary shock:

g. FSI



Expansionary shock:

h. FSI



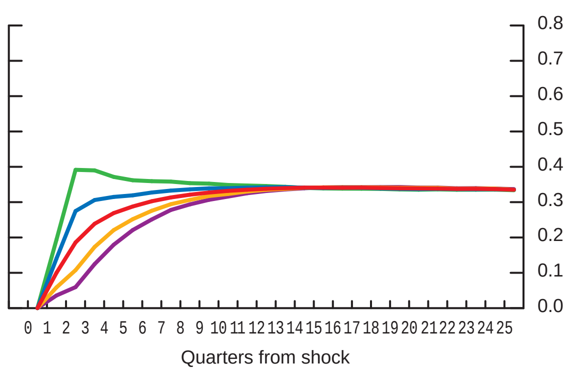
Source: Authors' calculations

sector when credit is already tight but weak effects when credit is initially plentiful. Hence, our empirical finding regarding the impact of a contractionary monetary policy shock on output growth is consistent with Blinder's view.

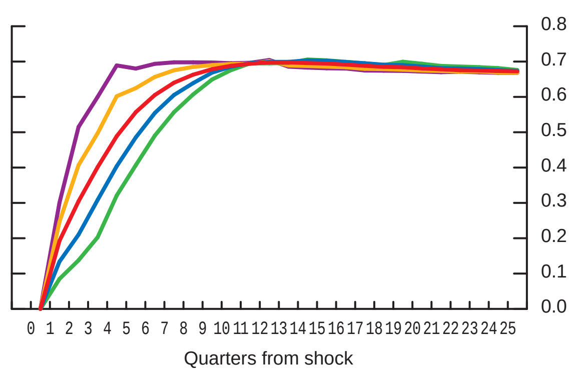
Chart 4 plots the estimated probability of a transition from one regime to the other. For comparison, the probability of such a transition in the absence of a monetary policy shock is also plotted. **Chart 4** indicates that contractionary monetary policy shocks can increase the likelihood of switching to, or staying in, a regime of high financial stress, while large expansionary shocks can increase the likelihood of moving to, or remaining in, a regime of low financial stress. Larger shocks have more impact on the likelihood of regime switching. These results suggest that monetary policy shocks have an impact on the FSI and play an important role in the evolution of financial-stress regimes.

Chart 4: Impact of monetary policy shocks on the probability of transition

a. Probability of transition from low-stress to high-stress regime



b. Probability of transition from high-stress to low-stress regime



No shock — One-SD contractionary shock — Two-SD contractionary shock — One-SD expansionary shock — Two-SD expansionary shock

Source: Authors' calculations

Conclusions

Some previous research has emphasized the role that financial sector developments could play in the transmission mechanism of monetary policy. Both theoretical models and empirical findings point to the possibility that there are non-linear relationships between monetary policy, the business cycle, and developments in the financial sector.

Using Canadian data and a TVAR model that allows for such non-linear relationships, we obtain results that are generally consistent with the previous literature. That is, when the economy can move into different financial-stress regimes, monetary policy actions can influence the likelihood of moving into these regimes, and monetary policy tightening appears to have more powerful effects, in general, than monetary policy easing. Moreover, the effects of tighter monetary policy are particularly large in regimes of high financial stress.

These results point to the need for policy-makers to take into account the impact that their actions might have on financial conditions. They also point to the need to be aware of the possibility that conditions in the financial sector influence the effects of policy actions. These transmission mechanisms must be factored into the models used to guide monetary policy decisions. While progress has been made in developing such models, much remains to be done.

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The empirical models discussed in this article are simple, however, and care must be taken in interpreting the results. Also, Canada has experienced only a few episodes of very high financial stress, and these could be driving our results. More research is needed before strong policy conclusions can be reached. In addition, our results should not be seen to imply that monetary policy should remain easy in order to avoid situations of high financial stress. Another, related literature shows that excessive growth in credit and asset prices, associated with a monetary policy that is kept too easy for too long, can be a source of disequilibrium that may eventually result in high financial stress.[11] Easy monetary policy could produce such developments. More generally, a monetary policy stance that is kept too easy for too long would cause inflation and instability.

11 See Borio and Lowe (2002) for international evidence with a detailed discussion. See also Misina and Tkacz (2009) and Misina, St-Amant, and Tkacz (2008) for evidence and discussion in a Canadian context. Boivin, Lane, and Meh (2010) provide analysis, based on general-equilibrium models of how monetary policy can affect financial imbalances.

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