Credit, Asset Prices, and Financial Stress in Canada

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Despite the apparent uniqueness of each financial cycle—from the conditions that lead to boom times, to triggers that result in the reversals—historical narratives (e.g., Kindleberger and Aliber 2005) suggest that most cycles display common features: boom times are typically associated with periods of credit expansion and persistent increases in asset prices, often followed by rapid reversals.

These commonalities, confirmed by recent empirical work (e.g., Borio and Lowe 2002; Kaminsky and Reinhart 1999), suggest that developments in the credit and asset markets of individual countries may provide an early-warning indicator of vulnerability in the financial system that would be useful in assessing the current situation and in discussions of possible policy actions. To arrive at a useful set of predictors for a particular country, however, the information content of different types and measures of credit (business credit, household credit) and asset prices (stock prices, bond prices, real estate) must be assessed for that country.

Assessing the usefulness of credit and asset prices as early-warning indicators in Canada is problematic, given the scarcity of events that would qualify as financial crises. Bordo et al. (2001) find that Canada has not experienced any "twin crises" (banking and currency crises) since the beginning of their sample in 1883. The absence of financial crises does not mean that Canada's financial system has not, or cannot, come under stress. Financial stress, even if it is not accompanied by the widespread failures of financial institutions usually associated with financial crises, can disrupt the financial system, which may have implications for real economic activity.

Although it seems plausible to postulate that expansions in credit and asset prices may be associated with increased financial stress, the empirical work that examines this link has been hindered by vagueness that is, to some extent, inevitable, in the definition of financial stress, and the consequent difficulties in quantifying it.

In this report, we describe the work done at the Bank of Canada on conceptualizing and measuring stress in the Canadian financial system (Illing and Liu 2003, 2006), and the work on the performance of various measures of credit and asset prices as early-warning indicators of financial system vulnerability, both historically and in the latest episode (Misina and Tkacz 2008).

Measuring Financial Stress Using the Financial Stress Index

Financial stress can be characterized as a situation in which large parts of the financial sector face the prospect of large financial losses. These situations are usually accompanied by an increased degree of perceived risk (a widening of the distribution of probable losses) and uncertainty (decreased confidence in the shape of that distribution).

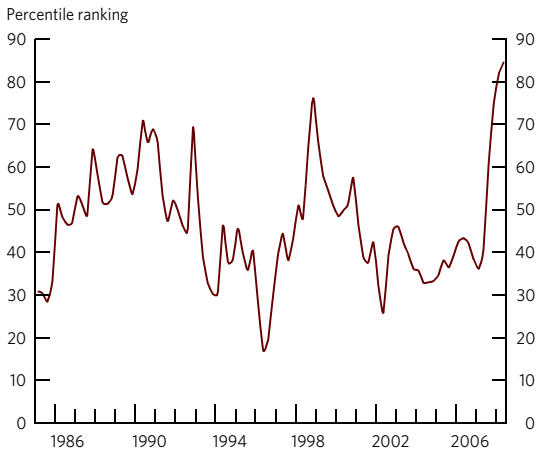
To capture these features of financial stress, Illing and Liu (2003, 2006) constructed a weighted average of various indicators of expected loss, risk, and uncertainty in the financial sector. The resulting financial stress index (FSI) is a continuous, broad-based measure that includes the following indicators from equity, bond, and foreign exchange markets, as well as indicators of banking sector performance:

- the spread between the yields on bonds issued by Canadian financial institutions and on government bonds of comparable duration
- the spread between yields on Canadian non-financial corporate bonds and government bonds
- the inverted term spread (i.e., the 90-day treasury bill rate minus the yield on 10-year government bonds)
- a beta variable derived from the total return index for Canadian financial institutions
- volatility of the trade-weighted Canadian dollar
- stock market volatility (TSX)

- the difference between Canadian and U.S. government short-term borrowing rates
- the average bid/ask spread on Canadian treasury bills
- the spread between rates on Canadian commercial paper and treasury bills of comparable duration

In constructing the FSI, Illing and Liu considered several weighting options and settled on weights that reflect relative shares of credit for particular sectors in the economy. The resulting index was most effective in correctly signalling events that are widely associated with high financial stress (e.g., the U.S. stock market crash in October 1987, the peso crisis in 1994, the LTCM crisis in 1998). The index is shown in Chart 1.

Chart 1
Financial Stress Index



Illing and Liu emphasize that the FSI provides a timely snapshot of *contemporaneous* stress in the Canadian financial system, and is not a leading indicator. That feature of the index is particularly evident in the recent episode. While the index performed very well in capturing the increased financial stress that started in August 2007, it did not foreshadow the problems.

The fact that the FSI has correctly indicated increased stress in the most recent period is encouraging,[1] but being a contemporaneous measure, it is of limited use as an early-warning indicator of possible problems.

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In a recent paper, Misina and Tkacz (2008) combine the insights offered by Borio and Lowe's work with the work on the FSI and ask to what extent various measures of credit and asset prices can help identify vulnerability in the financial system ahead of the episodes of stress.

It is important to emphasize that the objective of this exercise is not to forecast idiosyncratic events that cause reversals (an impossible task using any econometric model), but rather to assess whether, historically, there has been a relationship between the various measures of movements in credit and asset prices at time *t* and the FSI *k* periods ahead. The working hypothesis is that movements in credit and asset prices are indicators of the health of the system and its ability to withstand various types of shocks. Since the impact of a shock depends not only on the state of the system, but also on the magnitude of the shock, one would expect that, everything else being the same, excessive growth of credit and persistent increases in asset prices reduce the ability of the system to withstand shocks.

To test their hypothesis, the authors consider a broad range of measures of credit and asset prices, as well as various domestic and international variables:

- credit measures: the growth rates of total household credit, total business credit, and total credit/GDP
- asset prices (growth rates): stock prices (TSX), commercial real estate (nominal and real price indexes), residential real estate (new and existing house price indexes), average house price to personal disposable income; Canadian-dollar price of gold (Gold C$)
- macroeconomic variables: investment/GDP, the growth rate of money (M1++ and M2++), inflation (total CPI and core CPI)
- foreign variables: price of crude oil, asset-price indexes (United States, Australia, Japan), global GDP, U.S. bank credit, U.S. federal funds rate

Starting from this broad range of variables, the authors identify the most promising models by comparing the forecasting power of a wide range of specifications with that of a simple benchmark model in which the current FSI is a linear function of its own lagged value (*k*-quarters).[2]

1. The FSI was designed to ensure that it captured historical episodes of financial stress; the latest episode is a real-time test case.

2. Given the multitude of horizons (from one quarter to three years ahead) and variables under consideration, this alone requires the assessment of several thousand models.

Chart 2
Actual and Predicted FSI Using the Best Threshold Model
1-year forecasting horizon

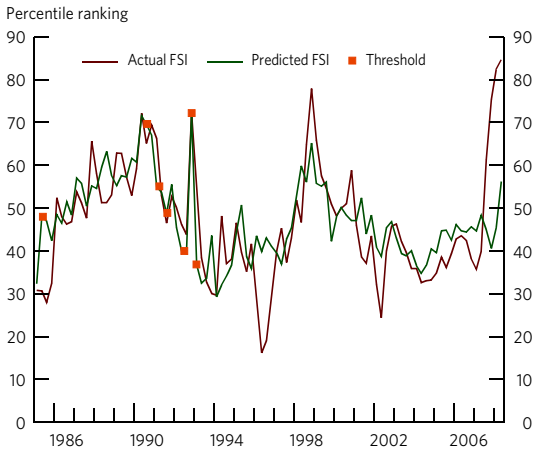
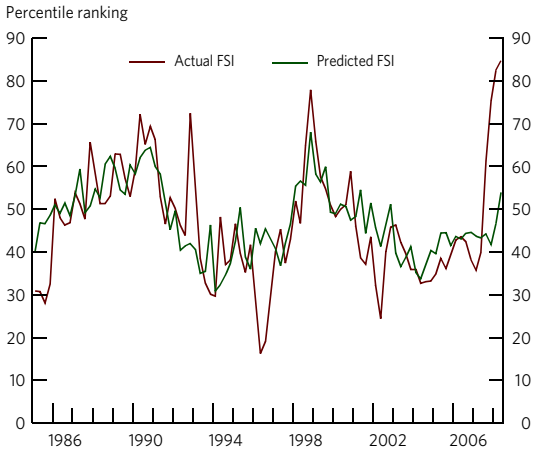


Chart 3
Actual and Predicted FSI Using the Best Linear Model
1-year forecasting horizon



In performing this exercise, both linear and threshold specifications are considered. If one believes that unusually large movements in asset prices, credit, monetary expansion, etc. may lead to changes in underlying relationships (because of "irrational exuberance," for example), then the relationship between some of the explanatory variables and the FSI may be non-linear. Misina and Tkacz approximate non-linear relationships by allowing for threshold effects between the explanatory variables and the FSI, such that the parameters of the models are allowed to differ when the explanatory variables lie above or below their threshold values. The methodology employed allows for the possibility of threshold effects in each of the 24 explanatory variables, as well as the possibility that the variable triggering a regime change differs from the variables that are the best predictors of financial stress within a regime.[3]

The best models are selected using the data that span the period 1984 to 2006. The forecasting exercise is performed over the period 1996 to 2006.

The findings can be summarized as follows:

- Within a linear framework, the credit growth of domestic business is the best predictor of the FSI at all horizons.
- Various domestic asset prices tend to be better predictors of the FSI when non-linearities are allowed for, suggesting that extreme movements in asset prices have a disproportionate impact on financial stress.
- At the one- and two-year horizons, domestic business credit and real estate prices emerge as important predictors of financial stress. This confirms the general findings of Borio and Lowe regarding the importance of considering credit and asset prices jointly rather than in isolation.
- Various measures of real estate prices are identified as the key threshold variables in the best threshold models (1- to 3-year horizon). The authors do not find a significant threshold effect in any measure of credit.
- With the exception of the federal funds rate at short horizons (two quarters), inclusion of international variables does not usually lead to improved forecasting performance relative to the benchmark model.

The forecasting performance of the best threshold models is significantly better than that of the best linear models, suggesting that non-linearities play an important role in capturing episodes of financial stress, a finding very much in line with the observations of Misina and Tessier (2007, 2008) on the importance of non-linearities in capturing the extreme movements associated with stress.

Chart 2 shows the actual FSI and the value predicted four quarters ahead by Misina and Tkacz's preferred threshold model, in which the threshold variable is the ratio of the average house price to per capita personal disposable income, and the explanatory variable is, in addition to that variable, domestic business credit.[4] In general, the model performs reasonably well in tracking the trend and turning points of the FSI. The

3. By contrast, Borio and Lowe pre-specify both the threshold variables (credit and asset prices). In addition, their thresholds are exogenously given, whereas in Misina and Tkacz, they are estimated endogenously.

4. The threshold marks on Chart 2 indicate the periods in which the threshold variable crossed the endogenously estimated threshold value.

best linear model (Chart 3) fails to capture some of the more extreme movements in the FSI over this period.[5]

Credit and Asset Prices in the Recent Episode of Financial Stress

In August 2007, the FSI increased sharply, pointing to considerable stress in the Canadian financial system. Indeed, in the recent episode, the FSI reached its historical high, indicating that this is the most stressful episode since 1985.

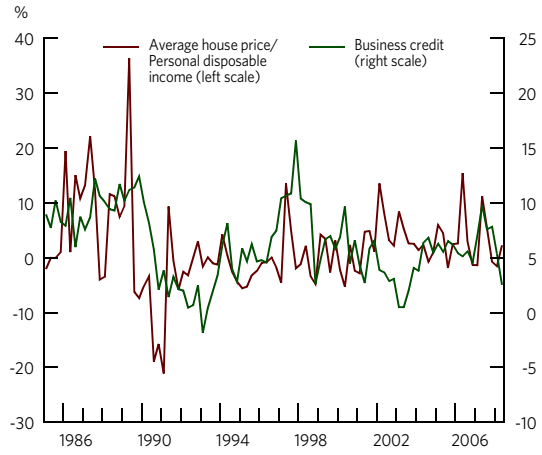
The results in Chart 2 indicate that, although the best forecasting model does generate an increase in the FSI, the magnitude of that increase underestimates the increase in the FSI by a large margin. This is not surprising, given that the increase in stress captured by the FSI was triggered largely by exogenous events (collapse of the U.S. subprime-mortgage market), but analysis of the behaviour of the explanatory variables can provide additional insights.

A look at the two key explanatory variables retained in the best threshold specification (Chart 4) reveals that, while both variables peaked in the second quarter of 2007, neither was close to its historical high. This may be an important contributing factor to the relatively good health of the Canadian financial system and its resilience to date.[6] Of course, the impact of a shock on the system is also a function of the magnitude of the shock, and the peak in the FSI, despite the good health of the system, indicates that this is a large shock by historical standards.

Summary and Further Work

The work described in this report indicates that a broad-based measure of financial stress, such as the FSI, can be a useful indicator of contemporaneous financial stress. Furthermore, the empirical evidence on the role of credit and asset prices in Canada in episodes of financial stress is consistent with historical narratives and the studies that examined this issue internationally.

Chart 4
Explanatory Variables
Annualized quarterly growth rate



The most promising model specifications can be included in the toolkit of early-warning indicators for the Canadian financial system, but the methodologies used to construct the FSI and to forecast it are general and are well suited to any country that exhibits the same characteristics as Canada (very few or no financial crises). A comparative exercise could provide insights into possible commonalities across countries, as well as differences.[7]

It is important to note that our analysis captures only the first-round effects of financial stress. Significant increases in financial stress may result in second-round effects, and may induce regime changes in the real economy.[8] Li and St-Amant (2008) explore this idea in a Canadian context by estimating a threshold in the FSI above which the economy behaves differently. They find that high financial stress regimes tend to be associated with weaker output, higher interest rates, and higher inflation.[9] These findings imply that taking account of the second-round effects is important and should be considered in any exercise that seeks to assess the longer-run consequences of financial stress.

5. The root-mean-squared error (our measure of forecasting performance) for the best non-linear specification is 0.54, which is significantly lower than that for the linear model (0.78). A root-mean-squared error of 1 indicates no improvement relative to the benchmark.

6. Some caution is necessary in drawing conclusions based on real-time data, owing to data revisions. Credit aggregates are periodically revised to include new instruments, but the revised data are not available in real-time exercises. This issue may be of particular importance when dealing with episodes such as the recent one, characterized by strong financial innovation and an emergence of alternative sources and instruments of financing. Some of these are not included in the data. For instance, venture capital and private equity financing (two sources of financing that were very vigorous in the period preceding the 2007 turmoil) are not included in the data. Lending by hedge funds and some asset-backed securities (e.g., commodity-linked notes) are captured either partially or not at all. A recent work by Keshishbanoosy et al. (2008) examines the nature and extent of the revisions in Canadian credit aggregates, and finds that they tend to be revised up in the quarters and years following their first release.

7. In a step in this direction, IMF (2008) introduces FSIs for several countries. Unfortunately, the choice of subcomponents and the method of aggregation deviate from Illing and Liu's recommendations, making direct comparisons difficult.

8. Some papers, e.g., Azariadis and Smith (1998), present theoretical arguments for this. Balke (2000) and Atanasova (2003) present empirical evidence, based on U.S. and U.K. data, respectively, that different degrees of tightness in credit conditions can cause regime changes.

9. For example, the authors find that there is a moderate negative correlation between the FSI today and real GDP growth two years ahead, as well as a moderate positive correlation between today's GDP and the FSI two years ahead. These results suggest the presence of two-way links between financial stress and the economy, but more work is needed to assess their significance.

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