Analyzing the Evolution of Financial Instability Risk

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The stability of the financial system[1] has always been important to central banks. Indeed, some central banks were created for the express purpose of preserving financial system stability.[2] Interest in this area was heightened by several episodes of pronounced stress on financial systems between 1990 and 2000 (the Asian crisis, the Long-Term Capital Management affair, the boom and bust in technology stocks, etc.). These events revealed that the inflation-control policies adopted by many central banks were not sufficient to guarantee the stability of the financial system, even though they did contribute to it.

In addition to having an inflation-control policy, the Bank of Canada contributes to financial stability in several ways. It provides liquidity to financial institutions under normal and exceptional circumstances. It advises the federal government on policies related to the financial system. It oversees Canada's major clearing and settlement systems. It offers banking services to those who operate and use these systems. It collaborates with other national and international bodies that promote financial stability. Finally, it analyzes the evolution of risks likely to undermine this stability (systemic risk). This paper examines this final contribution.

The analysis of systemic risk yields valuable information for all activities aimed at promoting financial stability. For example, the Bank must have a thorough understanding of the state of the financial system if it is called upon to inject liquidity into this system in the event of an exceptionally serious problem. The results are shared with other organizations involved in promoting stability in the financial system (prudential authorities) and with the general public, primarily through the *Financial System Review*.[3] The Bank's intent is for this information to contribute to both the better functioning of financial markets and to improved policy design. Finally, the Bank's analysis of systemic risk provides invaluable information for the conduct of monetary policy, given that financial instability tends to depress global demand and make a monetary policy response necessary.[4]

Assessing the evolution of risks that undercut financial instability is no simple matter, since the financial system has become much more complex and integrated, both nationally and internationally, in the wake of the policy liberalization and financial innovations that marked recent decades (Freedman and Goodlet 2002; Freedman and Engert 2003; Houben, Kakes, and Schinasi 2004). The challenge is magnified by the fact that there is currently no acknowledged theory or empirical model to guide central

1. The financial system consists of financial institutions, financial markets, and clearing and settlement systems. This system is unstable if impediments to its good functioning are likely to result in a significant decline in real GDP. Otherwise, it is considered to be stable.
2. The U.S. Federal Reserve System was created in 1913 in response to the panic selling that shook the U.S. financial system in 1907 (Ferguson 2002).
3. The Bank of Canada's principal partners in promoting financial stability in Canada are the federal Department of Finance, the Office of the Superintendent of Financial Institutions, and the Canada Deposit Insurance Corporation. The mandates of central banks in this matter vary from one country to another. Healey (2001) and Oosterloo and de Haan (2004) describe these differences.
4. Some authors (Borio and White 2004) contend that monetary authorities should tighten monetary policy when a speculative bubble develops that could cause financial instability. Laidler (2004) offers a different point of view on the subject. Selody and Wilkins (2004) address this debate in the Canadian context.

banks in the matter. It is in this context that researchers and analysts, especially those at the Bank for International Settlements (BIS) (Crockett 2000; Borio 2003), have proposed the macroprudential approach.

In this article, we briefly describe this approach and evaluate to what extent it can guide the analysis of risk. We conclude that the macroprudential approach provides a useful analytical framework, but that it needs to be supplemented by theoretical and empirical models that allow systemic risk to be identified and better understood. We also review work that we believe may be able to furnish such models. Much remains to be done in this field, and research needs to be ongoing. We conclude by proposing several avenues of future research.

The Macroprudential Approach

The term "macroprudential approach" was initially used to describe analysis that encompasses the entire financial system, rather than focussing on a particular element. In the early 2000s, economists at the BIS proposed this approach as a policy guide for authorities promoting financial stability (Crockett 2000; Borio 2003). The concept was taken up by many central banks, as well as by economists at international financial institutions (Tumpel Gugerell 2002; Selialia 2003; Hoenig 2004; Houben, Kakes, and Schinasi 2004; Gjedrem 2005).

Economists who advocate the macroprudential approach contrast it with the microprudential approach, which concentrates on individual contracts and organizations and, ultimately, strives to protect investors and depositors. The microprudential approach attempts to accomplish this by limiting the individual risks to which certain specific agents are exposed. It treats systemic risk as exogenous, in the sense that it does not depend on the reactions of financial agents. In this framework, the correlation in the activities of individual agents is not considered, and systemic risk is simply the sum of individual risks. Consequently, in its most extreme form, the microprudential approach considers the soundness of institutions taken individually to be both necessary and sufficient for the stability of the system.

The macroprudential approach treats the financial system as a whole, and its ultimate goal is to limit systemic risk. It recognizes the endogenous nature of systemic risk, which may be caused by the actions of financial-system stakeholders. For example, strategic decisions made by banks, including the decision to increase the share of an asset in their portfolios, can contribute to systemic risk. The correlation between decisions made by individual agents thus plays a key role in the evolution of risks. Decisions that appear innocuous when taken individually may, in fact, represent a threat to the financial system if they are taken by many agents. Thus, the fact that a single, medium-sized bank decides to increase the proportion of mortgage loans in overall loans may not increase systemic risk. But, if all banks simultaneously do the same, systemic risk may be exacerbated. The entire financial system is now exposed to a less-diversified risk. Moreover, the greater supply of mortgage credit implied by such a shift could trigger a real estate bubble. The eventual bursting of this bubble could cause hardship to economic agents through an erosion in the value of their real-estate holdings, as well as to those who provide the mortgage credit. We have chosen to illustrate this principle with mortgage credit, but systemic risk can also result from decisions taken in other areas of the financial system. Authorities who focus on the decisions of individual financial agents without accounting for the correlations between these decisions may be ignoring a very important source of systemic risk. The macroprudential approach to risk assessment imposes this accounting.

In practice, policy-makers often draw on both the micro- and macroprudential approaches. Consequently, in its role as lender of last resort, the Bank of Canada can provide liquidity to a bank that it deems healthy, but that is experiencing temporary liquidity problems. The goal is to protect economic agents from the consequences of market failure arising from a lack of information. Under the same policy, however, the Bank may inject liquidity into the entire financial system if it considers that such a measure might avert a significant systemic risk. In this case, the stability of the financial system is the primary concern.[5]

5. Daniel, Engert, and Maclean (2004–05) describe the Bank of Canada's lender-of-last-resort policy.

According to Borio (2003), the macroprudential approach implies that supervision and prudential standards are tailored to account for the marginal contribution of an institution to system-wide risk. This may have significant implications for prudential authorities; for example, in relaxing the surveillance of agents that are deemed to pose little, if any, risk to the stability of the financial system and in intensifying the scrutiny of those more likely to have a systemic impact. In practice, the breadth and complexity of the financial system means that it would not be feasible to expect the authorities to be able to analyze each of its elements in detail. Given this constraint, it seems more appropriate that they focus their efforts on those parts of the system considered to represent a heightened threat. Consequently, the macroprudential approach results in a more efficient use of resources for authorities seeking to limit systemic risk.

Nevertheless, it is important to bear in mind that there is currently no theoretical model or proven empirical model that establishes clear cause-and-effect relationships between the actions of participants in the financial system and any impact on its stability.[6] For the time being, the macroprudential approach is, instead, a collection of concepts that can point researchers towards the elements of a sound theory, which should both embrace and inform the intuition of decision makers as to which variables are key to defending financial stability.

Current Avenues of Research for Improving Analysis

In this section, we present several lines of current research at the Bank involving potentially useful models for overseeing and analyzing risk in the financial system.

The first is the contingent-claims approach (CCA), which proposes a method of measuring the evolution of risk in various sectors of the economy, as well as the transmission of risk between sectors. Next, are some approaches to the structural modelling of links between the real economy and the financial system.

The contingent-claims approach

The macroprudential approach recognizes the importance of shared exposure to certain shocks in the determination of systemic risk. The contingent-claims approach is a promising technique for accounting for these common exposures.

The CCA uses options-price valuation techniques to estimate a firm's risk of default based on the value and volatility of its capital stock and on the evolution of the book value of its debt.[7] The greater the volatility of its stock, the greater is the probability that the value of the firm's assets will fall below the value of its debt, and thus the greater is the probability that the firm will fail.[8]

Recently, Gray, Merton, and Bodie (2003) proposed a generalization of the CCA for the assessment of risk in different sectors of the economy (non-financial firms, banks, etc.).[9] They apply the CCA to a sector, rather than to an individual firm, by summing the market capitalization and debt load of each firm in the sector. The correlation between the yields on individual securities, which arises largely from the exposures shared by the issuers, is thus accounted for in the

6. Data problems are often an obstacle to the elaboration of solid empirical models. For example, owing to the absence of adequate data for some countries, Borio and Lowe (2002) were unable to integrate the price of real estate assets into their multi-country empirical models.

7. An option is a derivative whose value depends on the evolution of the price of the underlying asset. Merton (1973) was the first to conceptualize a firm's stock as analogous to a call option on its assets, with the value of the firm's debt being equivalent to the option's strike price. Thus, a stock is worth nothing if the value of the firm's assets is below the value of its debt (the option is "out of the money"). Otherwise, the value of the option is equal to the difference between the value of the assets and the value of the debt (it is, thus, "in the money").

8. Tudela and Young (2003) demonstrate that the CCA possesses the properties of an advanced indicator of the financial health of firms, beyond the information contained in their financial balance sheets.

9. See van den End and Tabbae (2005) and Gapen et al. (2004) for recent applications of this approach.

calculation of the volatility of the sectoral aggregate.[10] All other things being equal, the greater the shared exposure of firms, the greater is the volatility (approximated by the variance) of the sector's market capitalization, and thus the greater the sectoral risk identified by the CCA.

This framework also allows at least a partial evaluation of the transmission of risk from one sector to another via the links between the various sectors' financial balances. Researchers at the Bank of Canada currently apply this method to various subsectors of the non-financial sector and to banking. Our goal is to generate a useful measure of the evolution of risk in particular business sectors over time. Furthermore, sectoral analysis allows us to examine the share of the risk confronting banks that stems from their exposure to these various subsectors. The CCA is open to a wide variety of applications. For example, van den End and Tabbae (2005) apply this methodology to the household and pension fund sectors.

Modelling the links between the real economy and the financial system

Since risk is usually deemed systemic if it has potentially serious consequences for the real economy, and since the financial cycle and the business cycle are intimately linked, the macroprudential approach implies that it is necessary to better understand the links between the financial system and the real economy.

In light of the partial endogeneity of systemic risk, one approach currently being explored at the Bank and elsewhere consists of using various specifications and econometric models to estimate dynamic linkages between certain measures of the health of banks (e.g., yields, or provisions for loan losses) and various indicators of the macroeconomic and financial situation in Canada (GDP growth, interest rate levels, stock prices, etc.).[11] Since Canada is a small, open economy, the incorporation of factors such as commodity prices, U.S. interest rates, and U.S. growth rates as exogenous variables in models of the Canadian economy improves their specification. Such an approach allows the responses of the economy and of Canadian banks to exogenous shocks to be simulated. For example, the impact on Canadian banks of a significant slowdown in the U.S. economy and/or a sharp drop in commodity prices can be estimated. This approach is severely limited by the high degree of imprecision of econometric estimates as soon as the number of endogenous variables exceeds four or five.

Another econometric approach consists of estimating long-term relationships between real variables and certain key financial variables. Estimates of these relationships, provided they are stable, allow the identification of adjustments that could bring the economy into equilibrium.[12]

Considerable effort is also devoted to building dynamic general-equilibrium models that incorporate financial frictions. Specific attention has been paid to linkages between real-estate prices and the business cycle (Iacoviello 2005; Aoki, Proudman, and Vlieghe 2002), the role of bank capital in the propagation of economic shocks (Van den Heuvel 2004; Meh and Moran 2004), and the implications of the rationing of business financing for investment and economic activity in general (Bernanke, Gertler, and Gilchrist 1999; Christensen and Dib 2004).

For example, a model of the Canadian economy based on the work of Iacoviello (2005) incorporates financial frictions by assuming that some households are constrained by a liquidity shortfall. The amount that these households can borrow is limited to a fraction of their real-estate wealth, which introduces a financial-accelerator mechanism to the household sector. Assume that a shock drives up housing prices, all other things being equal. This shock allows constrained households to borrow more. They use

10. Lehar (2005) takes a somewhat different approach. He approximates the risk to a country's entire banking sector using the median of the covariance between the market values of the banks' assets generated by applying the CCA to individual banks. He then employs the idea that, under certain conditions, the total risk of a portfolio converges to the mean covariance (or the mean shared exposures) between the yields of the securities in the portfolio.

11. See Pain (2003); Mawdsley, McGuire, and O'Donnell (2004); Hoggarth and Whitley (2003); and Virolainen (2004).

12. See Pichette and Tremblay (2003), as well as Gauthier and Li (2006) for applications to the Canadian economy. Jacobson et al. (2001) and Cassola and Morana (2002) provide applications to other economies.

their additional funds to consume and invest more, which amplifies the effect of the initial shock on overall demand (this is called a financial accelerator) and may create additional upward pressure on the prices of goods and services, including the price of housing. This type of approach could prove very useful for the analysis of financial stability, at least to the extent that researchers are able to endogenize the other features of the financial system, especially the growth of speculative bubbles. Thus, the ideal model could distinguish between a speculative bubble and a rise in asset prices that is grounded in economic fundamentals.[13]

Moreover, markets appear to be afflicted with what Borio (2003) calls a "risk perception gap." Indeed, risk-perception indicators suggest that risk is usually perceived as low during the growth phase of the business cycle and high during recessions. In fact, there is ample evidence that risk increases during periods of expansion and is low when weaker agents have already declared bankruptcy. Markets appear to have difficulty integrating the externalities inherent in business cycles.

This phenomenon, which gives rise to a gap between the prices of assets and their fundamental value, could contribute to the development of speculative bubbles in financial markets. Several researchers have attempted to better understand this perception gap in the assessment of effective risk (Froot and O'Connell 2003; Gai and Vause 2004; Kumar and Persaud 2002; Tarashev, Tsatsaronis, and Karampatos 2003; and Misina 2003).

Conclusion

The macroprudential approach provides a useful conceptual framework that central banks and other prudential authorities should not hesitate to employ to guide their efforts in analyzing risk to the financial system. This conceptual framework is not a theoretical or empirical model, however. Construction of such models should be a research priority.

Significant progress has been made in the field. In this article, we have emphasized the promising nature of work that draws on the contingent-claims approach and on modern econometric methods with little or no theoretical content, and have also pointed to the potential of stochastic dynamic general-equilibrium models with financial frictions.

We believe that additional research into the following areas will be particularly beneficial:

- Application of the CCA to other sectors, such as households and pension funds, and the integration of sectoral risk into a measure of risk in the entire economy.
- Econometric analysis of panel data to examine the linkages between relevant macroeconomic variables and various sectors of the economy.
- Integration of several financial frictions into a single model. To date, most studies have tended to focus on one type of friction at a time. It would be interesting to look at the interaction of several types of friction within a single model.
- Endogenization of speculative bubbles into dynamic general-equilibrium models.

13. Scheinkman and Xiong (2003) provide an interesting example of this endeavour.

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