Monetary Policy and Uncertainty

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- *In formulating monetary policy, central banks must cope with substantial economic uncertainty.*
- *Economic uncertainty can arise from different sources: the state of the economy, the nature of economic relationships, and the magnitude and persistence of ongoing shocks.*
- *The Bank of Canada uses four particular strategies to deal with economic uncertainty. First, it brings together a wide range of information before decisions are made on setting its interest rate target. Second, it uses a number of carefully articulated models to produce economic projections and to examine alternative scenarios. Third, it chooses appropriate monetary policy reaction functions (or "rules") to use either in one specific model or across models. Fourth, it pays particular attention to the measurement of the output gap (the difference between output and the economy's production potential) and to alternative measures of pressures on the economy's production capacity.*

Uncertainty regarding what will happen in the Canadian economy comes in many forms and from many sources. In conducting monetary policy, the Bank of Canada must do its best to deal with this uncertainty, including the uncertainty that surrounds the transmission of its actions throughout the economy.

Experience has shown that there are two important steps a central bank can take in its conduct of monetary policy to help address uncertainty. First, it should establish a clear policy objective, and second, it should operate within a transparent framework for meeting that objective. Since the adoption of inflation targets in Canada in February 1991, the Bank of Canada has become increasingly transparent in both its operating framework and its communications (Thiessen 1995, 2000; Jenkins 2001). The progress made in these areas has reduced the private sector's uncertainty about how the Bank will act in response to economic developments. Moreover, it has tended to moderate the variability of inflation and of other important economic variables (Dodge 2002; Longworth 2002b).

Nevertheless, numerous types and sources of uncertainty remain. What is the best way for the Bank of Canada to deal with this uncertainty?

This article looks at examples of uncertainty that the Bank has encountered in recent years. It then characterizes the different types of uncertainty and reviews the Bank's approach to dealing with this problem. Three subsequent articles in this special issue then elaborate on three of the major strategies that the Bank employs in its approach.

Recent Events as Examples of Uncertainty

The increased attention being paid to uncertainty in the conduct of monetary policy reflects a number of developments. In the past 10 years or so, the focus has shifted from how to achieve low inflation to how to conduct monetary policy in an environment of low and stable inflation. This shift has led to a more systematic treatment of uncertainty. As well, the tools that have been developed and improved, such as the ability to carry out stochastic simulations,[1] have greatly facilitated the analysis and development of strategies for dealing with uncertainty. Finally, the liberalization of markets, by increasing international linkages, has added to the potential sources of economic and financial shocks, and thus to the sources of uncertainty, facing policy-makers.

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Many of the major shocks that the Bank of Canada has had to contend with over the past several years have been international in nature. These include the 1997–98 Asian and Russian crises, the deteriorating situation in Japan, developments in world commodity markets, the recent global economic slowdown, the "high tech" bubble of 2000, and the terrorist attacks of September 2001.

In each case, there was uncertainty about the magnitude of the effect that these developments would have on the Canadian economy, as well as uncertainty about their persistence. In some cases, the uncertainty was related to the fact that these developments worked through several channels in their impact on the Canadian economy. For example, the Asian crisis had spillover effects on Canada through financial markets, world commodity markets, direct trade links, and through our trading partners (most importantly the United States).

1. In stochastic simulations, economic models are subjected to a series of random shocks.

The starkest example of the type of uncertainty that monetary policy has had to confront recently was the situation immediately after the 11 September 2001 terrorist attacks on the United States. The circumstances and the uncertainties were unprecedented in North America. The effects were economic, financial, psychological, and geopolitical. Moreover, these effects exacerbated the considerable uncertainty that accompanied the global economic slowdown that began in late 2000 and gained momentum during 2001.

As a result, in its November 2001 *Monetary Policy Report*, the Bank of Canada shifted away from its usual approach of presenting a base-case projection of the Canadian economy. Instead, the Bank used a set of "working assumptions" to present several possible scenarios. The *Report* laid out two polar scenarios—one optimistic, one pessimistic—which depended on whether household and business confidence rebounded quickly or remained depressed. Between these two scenarios, a central scenario featured a wider-than-usual confidence band to capture the heightened degree of uncertainty.

These examples underscore how important it is for a central bank to develop techniques and procedures to deal with uncertainty when conducting policy. This involves being clear in its thinking about the different types of uncertainty that can arise and having the tools to analyze and form judgments about how to respond to that uncertainty.

Characterizing Various Types of Uncertainty

Uncertainty relates to the shocks hitting the economy, the duration of the shocks, the data that are available, the size of the parameters in an economic model, and the models of the economy that are used for analysis.[2]

Additive-shock uncertainty refers to the randomness in economic relationships. This randomness has no implications for policy decision-making in the normal case.[3] In particular, a change in the degree of variability of this randomness has no implication for how decisions should be made. In addition, uncertainty

2. This section draws heavily on Longworth and Freedman (2000) and on Freedman (2000).

3. The normal case is one in which the assumed model is linear and the policy-maker's loss function is quadratic (i.e., is a function of the sum of the squared deviations of variables around their target values). The result stated in the text is referred to as the "certainty equivalence" result.

about the future path of economic variables that are assumed to evolve independently of the course of the domestic economy,[4] such as foreign variables or certain domestic fiscal variables, is analogous to additive-shock uncertainty and thus has no implications for how decisions should be made. In other words, policy-makers should make their best forecasts of such variables and ignore the remaining unpredictable randomness in decision-making.

In response to *uncertainty about the duration of a shock*, policy-makers should base their actions on the typical persistence of such a shock in the past (which can be estimated from its historical behaviour, that is, its historical autocorrelations), unless better information is available. (The risks regarding the persistence of shocks could be explored by using alternative scenarios that work through the implications of assuming more or less persistence.) As more information about the shock is revealed, policy interest rates should be adjusted.

Data uncertainty refers to the possibility that data may be revised or that economic concepts are fundamentally mismeasured. As in the case of additive-shock uncertainty, the appropriate policy to be pursued is typically not affected by pure data uncertainty.[5] However, in cases where the central bank chooses to follow a simple policy interest rate rule that is a function of a very small number of variables, the coefficients attached to those variables may be significantly affected by data uncertainty. In particular, the central bank should typically respond with greater caution to a variable estimated with error than it would if there were no data uncertainty. For example, an increase in uncertainty regarding the output gap would typically reduce the coefficient on the output gap in the best simple rule (Rudebusch 2001). The implications of other types of data uncertainty are dealt with in Box 1.

4. These are commonly referred to as "exogenous" variables.

5. This holds in linear models when there is no uncertainty about the correct coefficients in the model.

Box 1

Implications of Other Types of Data Uncertainty

When several indicators are used to assess the degree of excess demand or supply,[1] increased uncertainty associated with one indicator will lead to a lower coefficient on that indicator and higher coefficients on other indicators, in the best monetary rule (Swanson 2000).[2] For example, if uncertainty about the size of the output gap increases, the relative weight on recent deviations of inflation from its target would be increased, and the relative weight on the traditional measure of the output gap would be decreased. In the limit, a weight of zero would be placed on the output gap (see, for example, Leitemo and Lønning 2001).

Another type of data uncertainty relates to the equilibrium value of a variable. A data-filtering technique is often needed to construct the best measure of that equilibrium. Laubach and Williams (2001) describe how a particular technique, the Kalman filter, can be used to jointly estimate the equilibrium real interest rate, the trend in the growth rate of output, and potential output. Various filtering techniques used by the Bank of Canada to generate measures of potential output (and the output gap) are considered later.

1. Some people talk about the uncertainty as to whether a shock is a demand shock or a supply shock. The way that most models deal with this is in the treatment of uncertainty about the output gap or other indicators of excess demand and supply.

2. Svensson and Woodford (2000) deal with a similar problem from the point of view of indicator variables.

Parameter uncertainty refers to uncertainty regarding the numerical values of parameters or coefficients in a given mathematical model of the economy. Increased uncertainty about key parameters in the model, such as the response of output to interest rates and the response of inflation to the output gap, should typically make policy-makers more cautious (Brainard 1967). See Box 2.

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Model uncertainty relates to more fundamental uncertainty about the structure of the economy than just parameter uncertainty or data uncertainty. It is possible, for example, that key elements of the way in which monetary policy is transmitted through the stock of money or through credit markets could be missing from models in which monetary policy works entirely through its effect on interest rates and exchange rates. Central banks deal with model uncertainty in two main ways.

In the first approach, the results from a number of different models—especially those representing fundamentally different paradigms—are examined. Engert and Selody (1998) and Selody (2001) argue that this strategy is likely to be useful, especially when the key behaviours underlying the transmission mechanism for monetary policy change as the economic environment changes. When such change occurs, it would be appropriate to set the monetary policy instrument according to the optimal path in the model representing the paradigm that is believed to best capture the current behaviour of the economy. More generally, the instrument paths in models representing various paradigms could be weighted by the assumed probabilities assigned to those paradigms.

Box 2

Parameter Uncertainty and Caution in Policy Response

When uncertainty about key parameters (such as the response of output to interest rates and the response of inflation to the output gap) rises, policy-makers should typically moderate the changes in their policy interest rate in response to a given change in the output gap or to a given change in the deviation of inflation from its target.[1] Parameter uncertainty is thus best dealt with by choosing appropriate coefficients in the reaction function (or "rule") for monetary policy in which the policy interest rate is set as a function of the output gap, the deviation of inflation from the target, and possibly certain other economic variables.

Uncertainty about the response of future inflation to current inflation works in the opposite direction to that of uncertainty about the response of output to interest rates. That is, greater uncertainty about the effect of current inflation on future inflation should cause policy-makers to strengthen their response to the output gap and the deviation of inflation from the target. Stronger action will minimize the potential for inflation to move away from its target (Srour 1999).

1. It is important not to exaggerate the scaling back of this response by policy-makers. For example, in the simple case, where only the response of output to the policy interest rate is uncertain, if the response is believed to be statistically significant (i.e., the *t*-statistic is at least two), one would scale back the response of the policy interest rate to both the output gap and the deviation of inflation from its target by, at most, 20 per cent, relative to the case where there was certainty about the parameters. This follows from the analysis in Brainard (1967).

In the second, a number of simple monetary policy rules are specified, and then their performance across various models of the economy is examined. If one particular rule works well in all these models, then it is said to be robust. The article by Côté et al. in this issue examines the robustness of certain simple monetary policy rules in various models of the Canadian economy.[6]

How the Bank of Canada Deals with Uncertainty

When making decisions on monetary policy, the Bank of Canada uses four particular strategies to deal with the pervasive uncertainty present in the economy.

- It has a process that brings together a wide range of information before decisions are made regarding the setting of the target for the overnight interest rate.
- It uses carefully articulated models to produce economic projections and to examine alternative assumptions about key variables.
- It chooses appropriate monetary policy reaction functions ("rules") for each model and uses alternative robust rules.
- It pays particular attention to the measurement of the output gap and to alternative measures of pressures on capacity.

Bringing together diverse sources of information

Given the complexities and uncertainties involved in the conduct of monetary policy, it is important that policy-makers have diverse and timely sources of information concerning the developments and trends in the economy. These information sources should include not just quantitative measures of economic developments and projections but also qualitative measures that reflect the views of a cross-section of economic agents (individuals, enterprises, and governments).

6. A third strategy found in the literature consists of specifying a simple model of the economy that captures features of the economy that almost everyone could agree on and then modelling other plausible descriptions of the world as varying degrees of autocorrelation in the error terms of the equations (Sargent 1999). The policy-makers are then assumed to follow a "minimax" strategy in which they choose the rule that minimizes the maximum loss across models (Hansen and Sargent 1998; Sargent 1999).

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In broad terms, the Bank relies on four sources of information (Macklem, this issue) to help it come to judgments about the economy and the appropriate stance of policy. First, it uses information on international and domestic economic developments in constructing its quarterly model-based projections. These projections are prepared by Bank staff and include the provision of alternative scenarios to judge the sensitivity of the projection to major risks and uncertainties. Second, it examines data on monetary and credit aggregates, as well as information on credit spreads and overall credit conditions. The purpose is to assess the behaviour of financial intermediaries, the financial conditions of households and of the business sector, and the implications for demand and inflation pressures in the economy. Third, the Bank's regional offices conduct regular visits with firms, associations, and provincial governments to assess economic developments. Although qualitative in nature, this information is pulled together by the Bank's regional staff to provide an important additional source of information about the national economic situation and outlook. Fourth, the Bank systematically assesses the views of financial markets, particularly in terms of the expected future movements in the prices and yields of various financial assets.

Using carefully articulated models

The projections produced with the assistance of economic models are central in the information considered. These models incorporate assumptions about the structure of the economy and how monetary policy is transmitted throughout the economy (Longworth 2000; Longworth and O'Reilly 2002).

The article by Coletti and Murchison in this issue explains the role of carefully articulated models in determining the implications of shocks for economic projections and the setting of interest rates. Models can be used to consider the implications of alternative

assumptions about important variables such as U.S. demand or oil prices. Coletti and Murchison focus on the Quarterly Projection Model (QPM), which is the model used to produce the key staff economic projection. They also discuss other economic models used in the process of putting together economic projections, especially the M1-VECM (Adam and Hendry 2000), a model that uses a monetary aggregate as a significant part of the monetary policy transmission mechanism. Other models used at the Bank, and which are based primarily on monetary aggregates or financial variables, are surveyed in Maclean (2001) and Longworth (2002a).

Choosing appropriate monetary policy reaction functions

Any model built to predict more than a quarter or two into the future must incorporate the behaviour of the central bank. This is usually done by including a monetary policy reaction function that explains the setting of a short-term interest rate as a function of a small number of macroeconomic variables. Armour and Côté (1999–2000) have surveyed these reaction functions in the context of inflation control. An effective reaction function is one that keeps inflation close to the target while also keeping output close to its potential level. [7, 8]

As its monetary policy reaction function, the QPM uses an inflation-forecast-based rule, where the future deviation of core inflation from its target is the main variable driving current interest rates. See Coté et al. in this issue, for details.

The article by Côté et al. also discusses other monetary policy reaction functions used at the Bank. In particular, they report the results of their search for a rule that would be robust across a wide variety of Canadian macroeconomic models. Although no rule has been found to be robust across all models, one particular rule was found to perform fairly well in several models and has been chosen for regular use in the staff briefings prior to a fixed announcement date.

Paying attention to the measurement of the output gap and capacity pressures

In the mainstream economic paradigm incorporated in the QPM, inflation is largely a function of inflation expectations and the output gap. The output gap is therefore a key variable in understanding the dynamics of inflation over time.

The primary measure of the output gap used by Bank staff is constructed using a variant of the multivariate-filter measure described in Butler (1996). Recent research has also used a Kalman-filter procedure (Kichian 1999). Unfortunately, it is notoriously difficult to measure the output gap with a high degree of accuracy, and many measures of the output gap have theoretical drawbacks (St-Amant and van Norden 1997; Cayen and van Norden 2002). For these reasons, the Bank does not come to a view on the degree of slack in the economy solely on the basis of one measure. Rather, it uses a wide range of indicators to come to a consensus as to the likely size of the output gap. These indicators of capacity pressures include Statistics Canada's measure of capacity utilization in the non-farm goods sector; the ratio of unfilled orders to shipments in manufacturing (excluding aerospace products and parts); measures of overall tightness in the labour market; measures of labour shortages (especially for skilled labour); vacancy rates for offices, industrial buildings, and apartments; and reports from the quarterly survey of firms conducted by the Bank's regional offices. Measures of underlying inflation, cost pressures, inflation surprises, and inflation expectations are also used to form a view of demand pressures on capacity.

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When examined together, the results from these four strategies provide the Bank with a comprehensive, balanced view of developments in the Canadian economy. This approach to dealing with uncertainty is a critical part of the Bank's strategy in its conduct of monetary policy.

7. That is, it leads to a low weighted average of the squared deviation of inflation from the target and the squared deviation of output from potential output (where the weights on the two terms are typically taken to be fairly similar, perhaps higher on the inflation gap in the case of inflation-targeting countries).

8. Some economists also suggest that the volatility of short-term interest rates should concern policy-makers.

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