BANK OF CANADA
BANQUE DU CANADA

Bank of Canada Review

Winter 2006–2007

www.bankofcanada.ca

Bank of Canada Review

Winter 2006–2007

Articles

Announcements

Cover

French Provincial Issues in Canada

Paul Berry, Chief Curator, Currency Museum

The issue of coins produced from base metals such as copper or billon, an alloy of copper mixed with a small percentage of silver, was not completely under royal control in France during the early seventeenth century. Several lesser or local authorities, including Maximilien de Béthune, duc de Sully, a state minister and childhood friend of Henry IV of France; Gaston d'Orléans, third son of Henry IV; and even Maffeo Barberini, Pope Urban VIII, issued coins in their own names. This was one of the last instances in France of what had been a common practice during the Middle Ages, when virtually any member of the aristocracy could issue coins. While these so-called feudal, or provincial, issues had originally included gold and silver coins, by the seventeenth century most of them were produced from base metals and issued in small denominations, ranging from *douzains* (12 *deniers*) to *liards* (three *deniers*), and from *doubles* (two *deniers*) to *deniers*. Based on documentary and archeological evidence, these coins, particularly the *doubles*, circulated throughout France in sizable numbers alongside regal issues. It should not be surprising, therefore, that feudal coins found their way to Canada.

Merchants in mid-seventeenth-century New France imported large quantities of these small-denomination French coins. Although the coins had been devalued in France, they could be circulated at a premium in New France (with substantial profit for the importer), given the perennial shortage of coinage in the colonies. It has always been thought that the coins imported for use in New France were regal issues in the name of Henry IV, Louis XIII, and Louis XIV. Recent excavations in Newfoundland and Quebec, however, suggest that the French provincial or feudal base-metal issues were used quite extensively in the monetary transactions of seventeenth-century Canada.

Doubles excavated on this side of the Atlantic come from various regions of France, including Boisbelle et Henrichemont (Berri), Bouillon and Rethel (Champagne), and Dombes (Provence). Their designs generally parallel those of official issues under the name of the reigning monarch, with a portrait of the individual in whose name the money was issued depicted on the obverse and at least three fleur-de-lys on the reverse. The latter design elements were supplemented with other objects of local or personal significance to the issuer, such as a castle tower, a flower, or a coat of arms.

Made of copper, the *doubles* are about the size of a one-cent piece. The coins pictured on the cover are part of the National Currency Collection, Bank of Canada.

Photography by Gord Carter, Ottawa.

The *Bank of Canada Review* is published quarterly, in print, and on the Bank's website (www.bankofcanada.ca). *Banking and Financial Statistics* is published monthly. Subscriptions are available to both publications.

***Bank of Canada Review* (quarterly)**

Delivery in Canada	CAN $25
Delivery to the United States	CAN $25
Delivery to all other countries, regular mail	CAN $50

***Banking and Financial Statistics* (monthly)**

Delivery in Canada	CAN $55
Delivery to the United States	CAN $55
Delivery to all other countries, regular mail	CAN $120

Canadian government and public libraries and libraries of Canadian and foreign educational institutions may subscribe at one-half the regular price. Single copies of the quarterly *Review* are $7.50. Single copies of the *Banking and Financial Statistics* are $5.00. Reprints of articles are available at $2.00 per copy.

Subscriptions or copies of Bank of Canada documents may be obtained from Publications Distribution, Communications Department, Bank of Canada, Ottawa, Ontario, Canada K1A 0G9; telephone 613 782-8248, toll free in North America: 1 877 728-8248; email address: publications@bankofcanada.ca. Remittances in Canadian dollars should be made payable to the Bank of Canada. Canadian orders must add 6 per cent GST as well as PST where applicable.

Inquiries related to interest rates or exchange rates should be directed to 613 782-7506.

Global Savings, Investment, and World Real Interest Rates

Brigitte Desroches and Michael Francis, International Department

- *Over the past 25 years, world long-term real interest rates have declined to levels not seen since the 1960s.*
- *This decline in the world real interest rate has been accompanied by falling world investment and savings rates. Looking at the behaviour of desired world savings and investment provides insights into the factors likely to have contributed to the decline in the world real interest rate.*
- *The behaviour of the world real interest rate has been affected by a number of key variables that change relatively slowly over time. These variables include labour force growth, which affects investment demand, and the age structure of the world economy, which influences savings. Other variables, such as the level of financial development, also affect savings.*
- *Since most of the key variables tend to change slowly, it is unlikely that they will be a source of significant changes in world interest rates in the near future.*

Over the past 25 years, long-term interest rates in the G–7 countries[1] have declined to levels not seen since the 1960s.[2] This decline reflects both a fall in inflation expectations and a decline in the real cost of borrowing. Although interest rates have increased in recent years with the cyclical expansion of the global economy and a moderate rise in inflation expectations, real long-term interest rates remain at their lowest level in more than 35 years.

As might be expected, the current low level of the world real interest rate is being closely linked to the other major international macroeconomic topic of concern; namely, large imbalances in current account positions among major countries, chiefly China and the United States. Although the two occurrences are undoubtedly related, it is interesting to note that while the emergence of global imbalances is a relatively recent phenomenon, the fall in real interest rates has developed gradually since the 1980s. Consequently, any investigation into the causes of the current low real interest rate must take into account not only the recent phenomenon, but also the long-term trends of the past 20 or more years (Knight 2006).

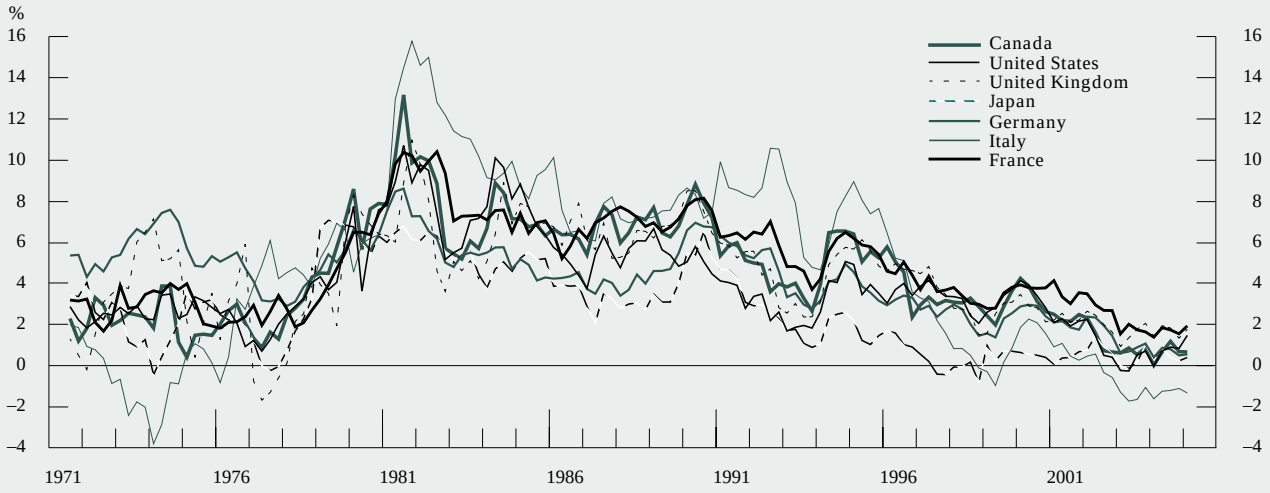
1. The G–7 countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

2. Increased integration of capital markets around the world has led to significant co-movement in national interest rates. The world interest rate shown in Chart 1 is based on the common component of ex ante five-year real long-term interest rates across the G–7 countries (see Box 1 for more details). For the other variables, the "world" is defined as 35 industrialized and emerging economies accounting for 94 per cent of the 2004 global real gross domestic product (GDP). See the Appendix for a description of the variables included in this study.

Box 1: Identifying the World Real Interest Rate

Chart B1

Ex Ante 5-Year Real Interest Rates for the G-7 Countries



Source:BIS, IMF, Bank of Canada calculations

Over the years, global capital markets have become highly integrated, and it is readily apparent in Chart B1—which shows the ex ante 5-year real rates for G–7 countries over the period from 1971 to 2005—that real interest rates across countries tend to move together. Indeed, the correlation between real interest rates suggests that there is a common global component to G–7 real interest rates that could be referred to as a world real interest rate.[1]

As Chart B1 also illustrates, however, real interest rates on sovereign debt are generally not equalized across countries, especially for some less-developed economies.[2] There are several possible reasons for this divergence. Interest rates may differ across countries because of the existence of country-specific risk premiums, perhaps owing to the possibility of sovereign default in countries with potentially unsustainable government debt burdens, or country-specific events such as the reunification of East and West Germany.[3]

The divergence can also be explained by the fact that capital markets are not fully integrated. For G–7 countries this is noticeable when the early period of relatively low real interest rates (1971–78) is compared with the recent period of low interest rates (from 1998 until today). The most obvious reason for this narrowing in real interest rate spreads is the removal of capital controls and financial regulations in the post-Bretton Woods era. Nevertheless, capital controls and regulations that limit arbitrage possibilities remain in a number of emerging markets and less-developed countries. China and India, for example, both employ capital controls that limit international capital flows, as well as an assortment of domestic controls aimed at directly influencing domestic interest rates.

Another possible reason for cross-country differences in observed real rates stems from an inability to define country-specific inflation expectations.[4] Any systemic measurement problem across economies (such as

1. Gagnon and Unferth (1995), for example, find strong evidence for, and were able to estimate, a common component to the real interest rate among a group of nine advanced economies, while Breedon, Henry, and Williams (1999) find evidence of a cointegrating relationship between the real interest rates on 10-year bond issues of the G–7 countries.

2. The hypothesis that real interest rates are not equal across countries has been confirmed by a number of studies. Mishkin (1982) found, for example, that short-term ex post real euro rates are not equal. Moreover, he found that real interest rates have dissimilar movements through time, although he could not rule out the tendency for real rates to converge over time. More recently, Gagnon and Unferth (1995) have also found that 12-month real rates differ significantly across economies.

3. A difference in real interest rates can also occur because of an expected movement in real exchange rates.

4. We estimate the inflation expectations using a regression for quarterly data on an index of consumer prices for each country. The functional form for the inflation regressions is an *AR* (*p*); expected inflation is thus based solely on the history of inflation. The estimated *AR* (*p*) processes have an order between 1 and 6, depending on the country, and the sum of the coefficients is between 0.98 and 1.02. The inflation expectations are calculated using 5-year ahead dynamic forecasts. Other measures of inflation expectations will be studied in future research.

Box 1: Identifying the World Real Interest Rate (cont'd)

country-specific differences in the calculation of inflation) could lead to systemic differences in the estimated real rates.

The existence of these country-specific factors suggests that, in some cases, domestic real interest rates may not be a reflection of global economic conditions. These differences make it difficult to estimate accurately a world rate of interest. The real rates shown in Chart B1 for the G–7 countries seem to suggest, however, that there is a common global component to real interest rates. G–7 financial markets are sufficiently integrated with world markets that their interest rates generally reflect the global savings and investment decisions. For this reason, when it comes to identifying the common factor in real interest rates that we refer to as "the world real interest rate," this study focuses on G–7 real interest rates.[5] These economies are all open and well diversified. Consequently, the extent of country-specific factors is likely to be less important compared with other small, less-industrialized countries or relatively closed economies.

5. We estimate the world real interest rate as the common factor across the G–7 countries, which is identified using a Kalman filter, a statistical tool used to estimate the common component of different variables (see Kalman 1960 for more details).

The purpose of this article is to explore the global forces that have led to the decline in the world real interest rate over recent decades, including the key factors that have shaped the behaviour of desired world savings and investment. The article begins with a description of the general trends in the world real interest rate, as well as global savings-investment outcomes from both international and national perspectives. The key factors driving investment demand and desired savings are then summarized. Finally, the contributions of various factors are quantified, and some insight is provided into the factors of particular importance for policy-makers.

Trends in the World Real Interest Rate, Savings, and Investment

The world real interest rate has exhibited a downward trend since its peak in the early 1980s. Indeed, it returned to levels experienced in the 1970s only relatively recently (Chart 1). Chart 2 shows that this decline in the world real interest rate has been accompanied by falling world investment and savings rates.

Although global investment demand and the supply of savings are equalized through movements in the real interest rate, access to international capital markets means that the actual level of domestic savings and investment realized in any particular country need not be equalized. In recent years, developments in net national savings have been dominated by large shortfalls in the United States and significant surpluses in the countries of emerging Asia and those belonging to the Organization of Oil-Exporting Countries.

In addition, the trends in gross savings and investment are not uniform worldwide (Charts 3 and 4). For example, Japan and the United States are the main sources of the decline in global savings, whereas the long-run decline in investment seems to stem from Japan and the other industrialized countries (Europe, Australia, and Canada). In contrast, emerging Asia has experienced growth in both investment and savings rates.[3]

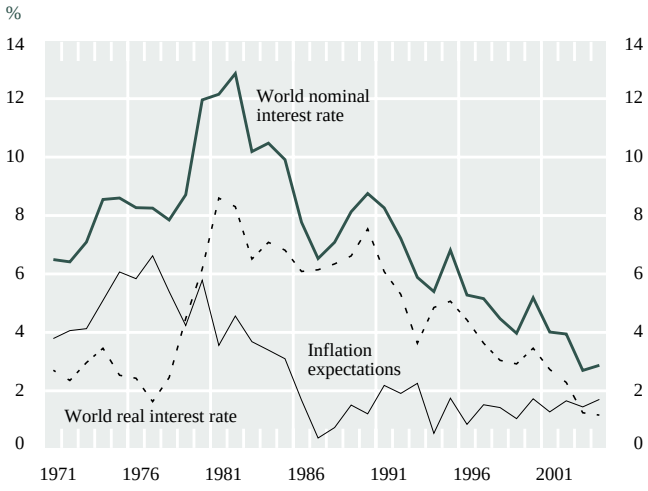
This decline in the world real interest rate has been accompanied by falling world investment and savings rates.

In order to go beyond a simple description of the data, we need to adopt a framework for thinking about how global savings and investment decisions are made and how they affect world real interest rates and the level of savings and investment undertaken.

3. Although world savings and investment must be identical by definition, world savings and investment may not be exactly equal in practice. In our analysis, we focus on a subset of countries in the world economy that account for 94 per cent of world GDP; hence, savings and investment rates are not likely to be equal. Furthermore, measurement problems raise additional complications in that the two statistics rarely equal one another even when a universal data set is used.

Chart 1

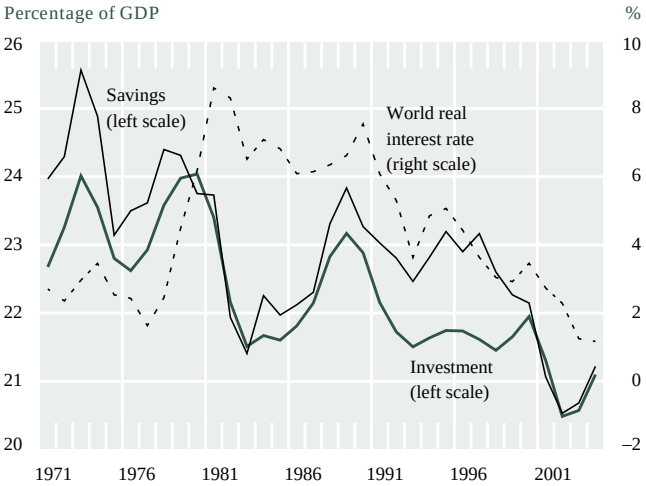
World Interest Rates and Inflation Expectations



Source: World Bank, BIS, IMF, Bank of Canada calculations

Chart 2

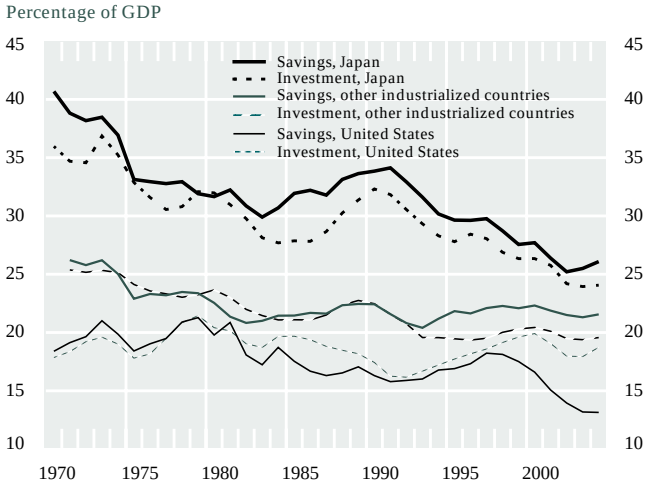
Global Savings, Investment, and the Real Rate of Interest



Source: World Bank, BIS, IMF, Eurostat, national official sources, Bank of Canada calculations

Chart 3

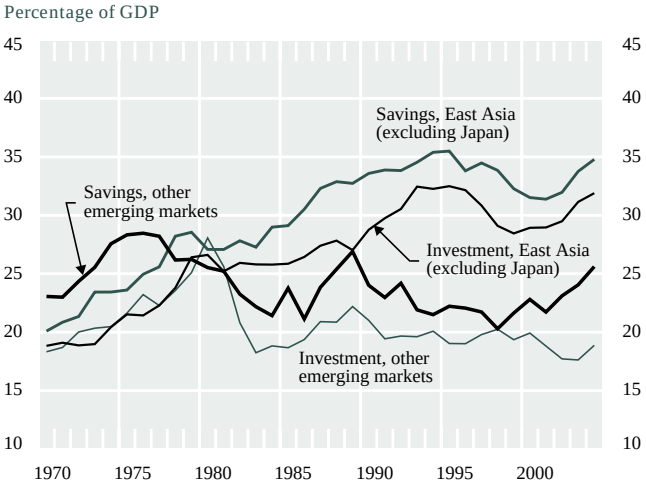
Savings and Investment Rates among Industrialized Countries



Source: World Bank, BIS, IMF, Eurostat, national official sources, Bank of Canada calculations

Chart 4

Savings and Investment Rates among Non-Industrialized Countries



Source: World Bank, BIS, IMF, Eurostat, national official sources, Bank of Canada calculations

The World Real Interest Rate and the Market for Savings and Investment

Economists agree that the real interest rate is determined in the market for investment and savings and thus by the forces of productivity and thrift. Hence, the real interest rate adjusts to equilibrate desired savings (providing the net supply of funds) with desired investment (generating the net demand for funds).[4] In an increasingly integrated world economy with internationally mobile capital, the real rate of interest is determined largely by global forces in the world market. Thus, for relatively small open economies, the world real rate of interest is somewhat independent of domestic circumstances, especially over the medium-to-long term.

In an increasingly integrated world economy with internationally mobile capital, the real rate of interest is determined largely by global forces in the world market.

Chart 5 is a graphical depiction of the global market for savings and investment. The world real interest rate is plotted on the vertical axis, and the quantity of savings / investment is on the horizontal axis. The desired investment schedule (I) traces out the net demand for funds for various levels of the real interest rate, holding constant the other factors that influence investment decisions. Similarly, the desired savings schedule (S^1) is the net supply of funds at various interest rates, holding constant the other factors that influence savings decisions. The world real interest rate, otherwise known as the real cost of funds, is the key price that adjusts in order to equalize desired savings and investment. For example, if desired demand exceeds desired supply, then the cost of funds will be bid up until supply and demand for funds are equalized.

In order to take this framework to the point where we can track the historical evolution of real interest rates, we need to allow for shifts in both the desired savings and desired investment schedules. For example, Chart 5 shows the implications of a downward shift in desired savings, from S^1 to S^2. This shift would result in a shortfall of savings, leading to upward pressure on interest rates, which would result in a fall in investment until the shortfall in savings was eliminated.

Chart 6 presents a scatter plot of the world real interest rate against the realized world rate of investment / savings. One possible interpretation of Chart 6 is that the net supply of savings had two distinct periods: the first, which one might consider to be before 1979 (highlighted by the savings-supply curve S_AS_A), and a subsequent period after 1983 (illustrated by the curve S_BS_B). During each of these two periods, it appears that the savings-supply equation was *relatively* stable, suggesting that variations in investment demand could be the dominant factor driving changes in the world interest rate. For example, in the late 1970s, there appears to have been an increase in the level of desired investment (a shift in the investment demand curve, not shown), which caused excess demand in the market, pushing real interest rates up along the savings-supply locus S_AS_A. Between 1979 and 1983, however, interest rates seem to have been pushed higher, primarily owing to a reduction in global savings plans, as illustrated by the shift of the savings-supply curve from S_AS_A to S_BS_B. In the period between 1983 and 1989, interest rates stayed high as investment demand remained strong. A final observation to be drawn from Chart 6 is that the low level of real interest rates that had appeared by 2004 seems more likely to be explained by a decade or more of weak investment demand than by an excess supply of savings. Indeed, relative to the early 1970s, when real interest rates were also low, the supply of global savings during and before 2004 appears to have fallen. Chart 6 naturally raises questions as to what caused these three significant shifts in desired savings and investment. With this in mind, the next section provides a conceptual overview of the key determinants of desired savings and investment.

What Drives Investment and Desired Savings?

Investment

Savings and investment decisions are made by each of the three sectors of the world economy: households, firms, and government. In the case of investment, however, firms are by far the most important source of investment demand.

4. The presence of an output gap would likely imply that the interest rate is not at its equilibrium level. In the empirical section, however, we assume that the long-run interest rate is in equilibrium.

Chart 5

The Market for Savings and Investment

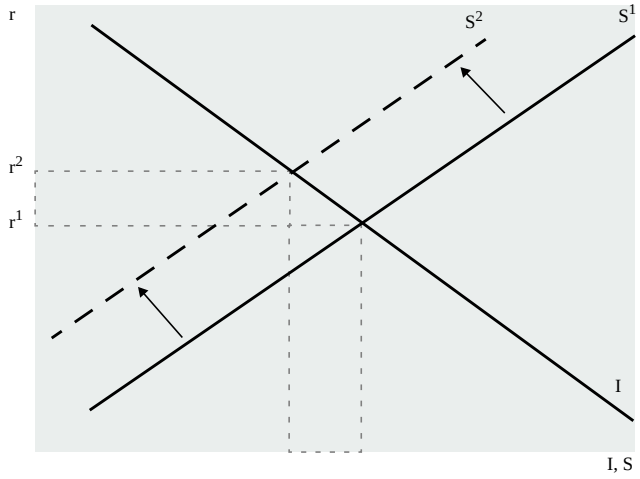
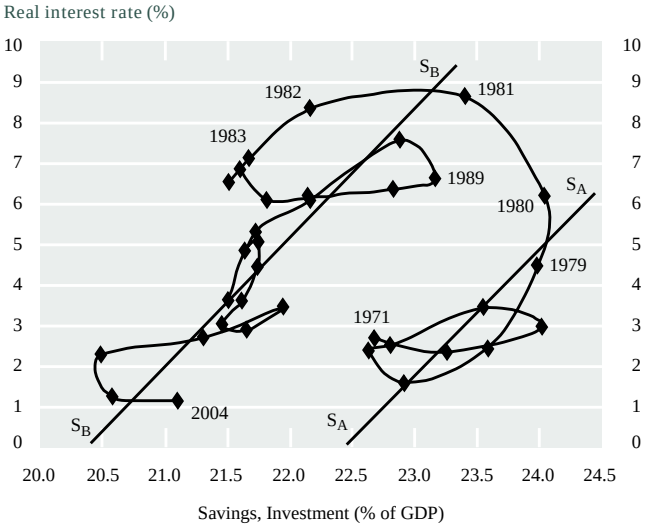


Chart 6

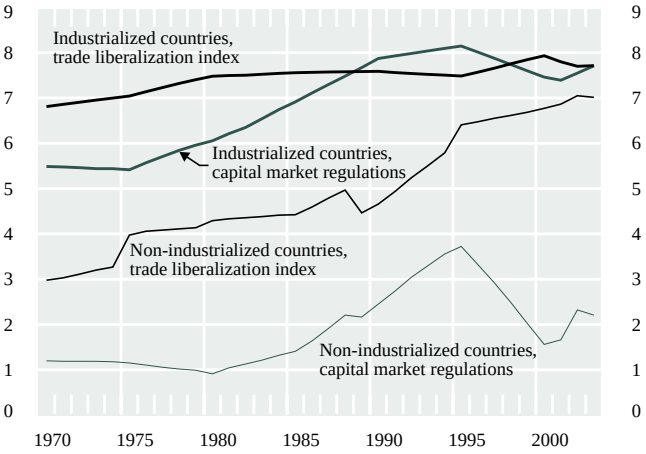
The Market for Savings and Investment



Source: World Bank, Eurostat, national data sources for individual countries, BIS, Bank of Canada calculations

Chart 7

Absence of Capital Market Regulations and Trade Liberalization Index



Note: An increase in the indexes represents a reduction in capital market regulations or an increase in trade.

Source: Fraser Institute, Bank of Canada calculations

Chart 8

Investment Rate and Growth of the Working-Age Population

Source: World Bank, Eurostat, national date sources for individual countries, BIS, Bank of Canada calculations

Economic and financial liberalization

One of the most significant events affecting the global economy over the past 25 years has been the substantial reduction in capital controls, tariffs, and other impediments to economic integration (Chart 7). By allowing resources to move more freely to regions and sectors where the return is highest, the removal of such impediments is likely to have raised overall firm profitability and expected returns on investment, thereby stimulating global investment demand.[5]

Labour force growth

One important determinant of investment demand is labour force growth. Low rates of labour force growth combined with high ratios of capital to labour help to explain why many industrialized countries face an apparent dearth of investment opportunities,[6] since a fall in labour force growth means that less investment is required to equip the labour force with capital. The effect on investment is more significant when the production process is capital intensive.[7] Thus, an increase in labour force growth in countries that use labour-intensive production techniques will generate a smaller increase in investment demand than it would in countries that employ capital-intensive techniques.

One important determinant of investment demand is labour force growth.

Chart 8 illustrates the GDP-weighted growth rate of the working-age population for the 35 countries in our data set, along with the world investment rate.[8] It can be seen that, although the growth rate of the working-age population increased between 1971 and 1982, it has generally fallen since then.[9] The data suggest that the behaviour of labour force growth could provide an explanation for two of the key trends mentioned earlier in our discussion of Chart 6—strong investment demand in the latter part of 1970s and the ongoing weakening of investment demand since the late 1980s.

Stock market returns

Another source of investment demand in addition to labour force growth is total factor productivity (TFP) growth. This factor, as well as other determinants of investment demand, are difficult to identify. Empirically, this problem can be partially addressed by examining the behaviour of stock prices.[10] Since the stock market is forward looking, stock market returns reflect expectations about a variety of factors and can contain information regarding shifts in the investment curve. A change in the marginal product of capital, for example, could be captured by movements in stock market returns.

Although most firms are not listed on stock exchanges, particularly in small emerging economies, stock prices are generally known to reflect expected future profitability, and hence, the value that can be gained by the firm through investment. Favourable stock market returns are therefore associated with stronger investment demand. Chart 9 shows that high world real rates of interest in the period from 1981 to 1986 could have been partly driven by favourable stock returns (which stimulated investment and raised real interest rates).

5. Financial liberalization was particularly important for many industrialized economies that substantially deregulated their domestic financial markets in the latter half of the 1970s. In emerging markets, the process of liberalization has been more gradual and still lags behind that of the industrialized economies. Indeed, the process of deregulation was partially reversed in the early 1990s, partly reflecting the experiences of many emerging markets with banking crises during the 1980s and 1990s.

6. This is discussed in Bernanke (2005).

7. This argument would be consistent with Leontief-style production functions in which each worker would have to be equipped with a certain amount of capital. Alternatively, the size of the labour force could affect investment demand by influencing demand for the final good.

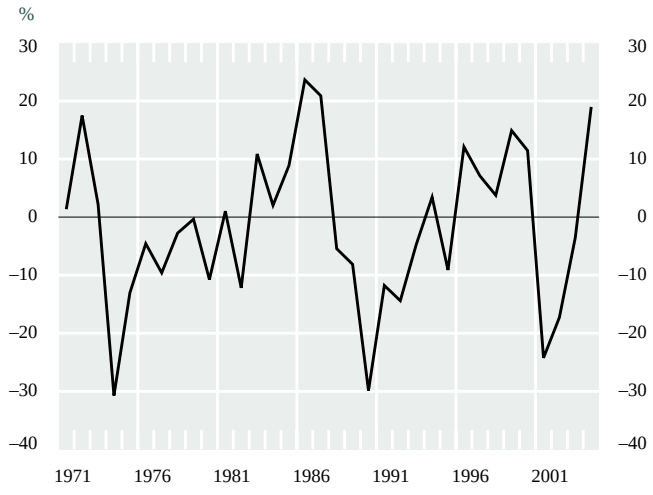
8. The working-age population is used as a proxy for the labour force because of limitations on the availability of data. A more detailed measure of the labour force would also take into account participation rates and hours worked. Technically, for the reasons outlined in the text, the aggregate for the working-age population should be capital weighted. However estimates of capital stocks are often unreliable for the purposes of making international comparisons over time and are unavailable for many of the countries in our data set. We therefore use real GDP weights as a proxy. This is a reasonable approximation because larger economies typically have larger capital stocks.

9. The fall in labour force growth in the 1980s became especially important in industrialized countries as the impact of baby boomers entering the labour force diminished.

10. Investment demand can be explained by a variable resembling Tobin's *q*, which is a measure that summarizes all information about the future that is relevant to a firm's investment decisions. Measures of stock market returns are taken to be a proxy for future expected profitability. See the Appendix for a description of the variables.

Chart 9

Real Stock Market Returns

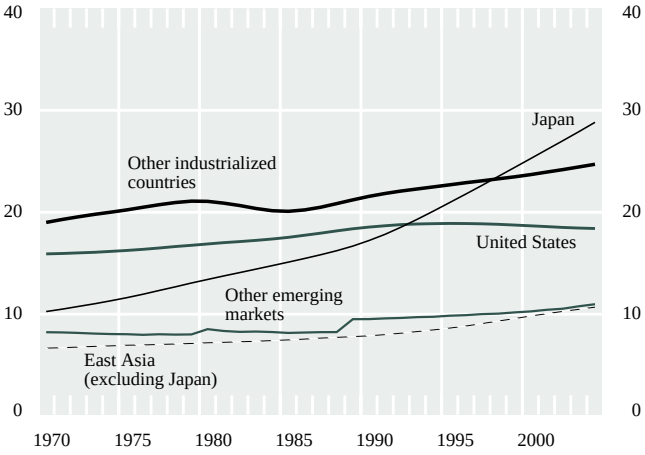


Source: IMF

Chart 10

Elderly Dependency Ratio

Percentage of working-age population

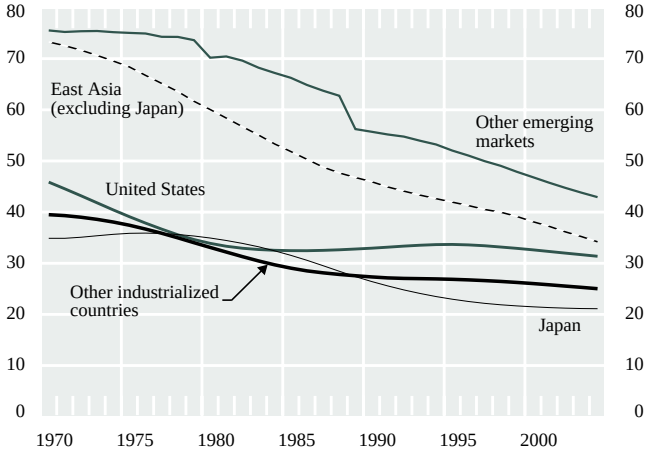


Source: World Bank, Bank of Canada calculations

Chart 11

Youth Dependency Ratio

Percentage of working-age population



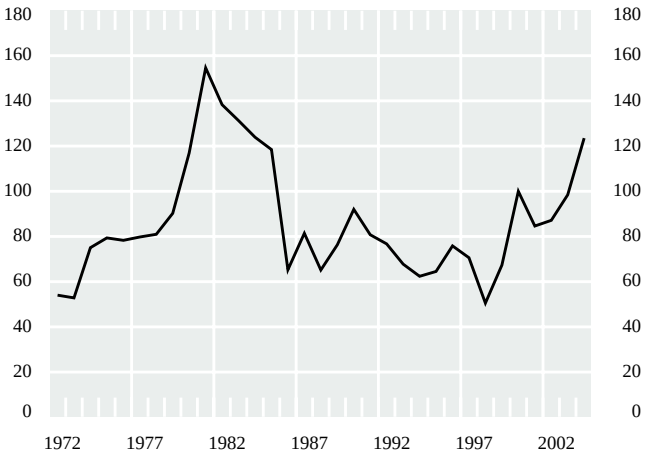
Source: World Bank, Bank of Canada calculations

Chart 12

Real Price of Oil

2000 = 100

US$



Source: IMF

Savings

While firms are the primary source of investment, savings plans by all three sectors of the world economy (households, firms, and government) have a significant effect on aggregate savings. This section describes the various factors that could provide an explanation for the decline in savings rates over the past 25 years.

Demographics

For households, savings decisions generally reflect a preference by individuals to smooth consumption over time. As a result of this consumption-smoothing preference, savings rates are thought to vary according to the individual's life cycle (Modigliani 1986). In particular, people are generally believed to have a relatively low ratio of savings to income when they are young and during the early stage of their careers, a high savings rate as they approach the end of their working life, and a low savings rate in retirement.[11]

Globally, the elderly dependency ratio (that is, those aged 65 and over relative to the population aged 15 to 64) has grown over time (Chart 10). This is true for most regions of the world, but particularly so in Japan, where the elderly dependency ratio rose from just over 10 per cent of the population in 1970 to close to 30 per cent in 2004. This trend would predict that savings rates should have declined over time.[12] On the other hand, the ratio of the young to the working-age population has fallen worldwide (Chart 11). These two effects tend to offset one another, making it unclear how they have affected the global savings rate over the past 25 years.

Fluctuations in income

Assuming that households prefer a smooth rather than a volatile consumption pattern over time, fluctuations in income are also likely to be an important determinant of movements of the savings rate (Friedman 1957). From the point of view of households, a temporary increase in real income (a windfall) can be expected to lead to a temporary increase in the savings rate as households try to save a larger portion of their income in order to finance a permanent rise in consumption. On the other hand, a permanent increase in income would imply a permanent increase in consumption and would therefore not require any changes in the savings rate in order for the household to enjoy a permanent increase in consumption.

We can think of the relative price of oil as an indicator of temporary world income.[13] From the point of view of households, a reduction in real incomes due to an increase in oil prices is likely to have relatively modest effects on aggregate consumption. However, since real incomes fall when oil prices rise, a temporary shock should cause savings rates to fall.[14] Chart 12 shows the real price of oil over time. Interestingly, the increase in oil prices in the early 1980s that is associated with the second oil shock is consistent with the sudden shift in the supply of savings that was hypothesized in Chart 6 (from $S_A S_A$ to $S_B S_B$), but it doesn't explain why the savings rate remained persistently low thereafter.

Financial development

Although it is often overlooked, the state of development in the financial sector—reflected in its ability to mobilize savings, allocate capital, and facilitate risk management—should, in theory, also be an important explanation for household savings rates, but the theoretical arguments go in both directions, and the empirical evidence is mixed. On one hand, a well-developed financial sector could stimulate household savings rates by offering a greater variety of savings vehicles that offer a higher rate of return than might otherwise be the case (Edwards 1995). On the other hand, there is evidence that improved financial sector development can reduce household savings rates by relaxing household borrowing constraints or by providing better insurance instruments that reduce the demand for precautionary savings (Jappelli and Pagano 1994).

As was noted in the discussion on investment, the 1980s was a decade of financial liberalization, particularly for industrialized countries. The asymmetric process of financial liberalization is one reason why household savings in industrialized countries may have fallen relative to that in less-industrialized economies.

---

11. Demographic trends also contribute to a shift in investors' portfolio preferences, affecting long-term interest rates. As a consequence of population aging, pension funds may shift their asset composition towards long-term bonds, contributing to lower yields. Although this portfolio reallocation might have magnified the recent decline in real interest rates, it cannot explain the long-run decline.

12. The empirical support for the life-cycle model of savings is mixed. Some studies find that households tend to save more than is predicted by the life-cycle model. A bequest motive is one possible explanation. Savings behaviour is also a function of life expectancy.

13. In their study of world real interest rates, Barro and Sala-i-Martin (1990) find that oil prices can be an important determinant of savings rates. In this regard, oil prices can also be thought of as a proxy variable, capturing factors such as disruptions of international markets, whose effects go beyond the immediate impact on the supply and demand of oil prices.

14. For oil exporters, however, a rise in oil prices would increase savings. The net effect of oil prices will be determined in the empirical results (p. 13).

More importantly for our study, the process of financial deregulation—given its timing, particularly in industrialized countries—could also explain why the supply of savings apparently remained weak in the 1980s after the effects of the oil crisis had diminished.

Fluctuations in corporate profits and the business regulatory environment

Firms, through their use of retained earnings, can also be an important source of savings. This has been particularly true over recent years, during which the corporate sector in the G–7 countries has gone from being a net borrower of funds to a net lender. One reason for this behaviour might be that firms see recent high profitability as temporary, and like households, are responding cautiously by using the windfall to finance future, rather than current, investment plans.[15] This postponement of investment implies that firms pay off debt rather than acquire new capital. Other determinants of savings may include regulatory and supervisory changes, which may have induced firms to try to improve their credit ratings.[16] This may be particularly true for financial sector firms, where improvements in supervisory standards and the removal of government guarantees have induced such firms to increase their capital base.

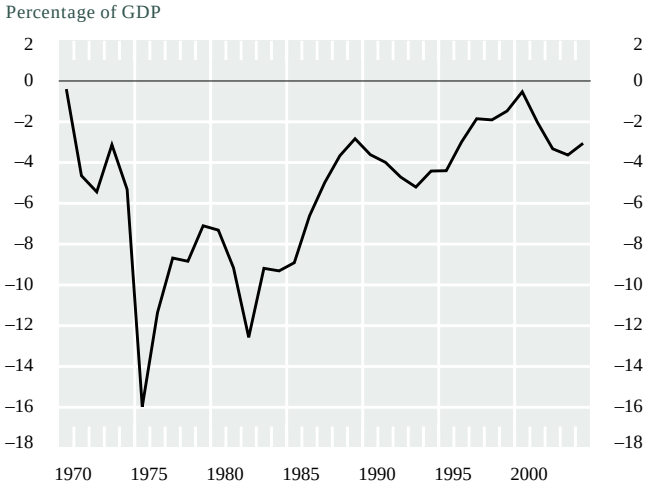
Fiscal and monetary policy

Governments also have a significant direct impact on aggregate savings. Governments are typically a source of dissaving because they have tended to run budget deficits by spending more than they raise in taxes. At times, the level of government dissaving around the globe has been substantial (Chart 13).[17] For this reason, fiscal deficits were a popular explanation for high world interest rates in the early to mid-1980s, when, as the analysis in Chart 6 indicates, savings appeared to fall significantly. Since then, fiscal deficits have declined dramatically, which, everything else remaining the same, should have led to higher savings and lower real interest rates.

That said, households may have viewed the decrease in fiscal deficits as meaning that their future tax liabilities were also being reduced.[18] If so, households can be expected to have responded to smaller deficits by lowering their savings and increasing their consumption. Thus, it is likely that the effect on aggregate savings of declining fiscal deficits may have been offset by lower household savings, albeit only partially. Empirical studies suggest that approximately one-third to one-half of any increase in government savings are offset by a decline in household savings (International Monetary Fund, IMF, 2005).

Chart 13

Real Government Surplus



Note: Excluding Mexico, Turkey, and Russia
Source: IMF, EIU, Eurostat, World Bank

Monetary policy may also contribute to explaining the recent decline in real interest rates. Monetary policy credibility established over a long period may have caused part of the decline in long-term rates through a reduction in the inflation-risk premium.

World distribution of income

Lastly, some observers have argued that global savings and investment rates have been affected by a shift in the world distribution of income.[19] Since income has been growing faster in emerging markets with high savings rates and less-developed financial sectors (where borrowing constraints are more important)

15. Lower desired investment could also reflect the absence of investment opportunities with sufficiently high expected returns.

16. For example, the U.S. Sarbanes-Oxley Act of 2002, which was enacted in response to financial scandals, introduced major changes in financial practices and corporate governance. Accounting changes also increased the demand for long-term bonds, contributing to the recent decline in bond yields.

17. The two troughs in 1975 and 1982 were periods of global recession.

18. The view that households will adjust their savings behaviour in response to changes in government spending because they take into account future tax liabilities is known as the Ricardian equivalence hypothesis. If true, aggregate savings should not respond to changes in government savings.

19. For example, if world income is redistributed from countries with low savings rates to countries with high savings rates, the world savings rate should rise, putting downward pressure on the world interest rate.

than in advanced economies with relatively low savings rates, the changing distribution of world income might be a possible explanation for the decline in world interest rates over recent years. We find, however, that the change in world income has not contributed significantly to changes in the world savings rate over time, because the fast-growing high savers do not yet represent a sufficiently large share of world savings for this effect to be dominant. This shift may become a more important factor in the future, however, as the importance of the high-saving economies grows.

In summary, many factors could account for the observed trends in the world real interest rate. The anecdotal evidence suggests that declining labour force growth may have been one important factor in the fall in investment demand since the mid-1980s, while the consequent decline in world interest rates would seem to account for the fall in savings during the same time. More difficult to explain is the fall in desired savings after 1979. There appears to have been a change in the relationship between the interest rate and the quantity of funds supplied. Graphically, Chart 6 shows, that, after 1979 the fall in desired savings appears to be the result of a leftward *shift* of the savings schedule rather than a movement *along* the curve (which would have been the case if savings had fallen in response to interest rate changes). The review of the evidence, however, points to several factors, including the effect from temporary rises in oil prices, financial deregulation, and the increasing ratio of elderly to young. The next section examines the results of a more formal empirical assessment of the issue.

Empirical Results

Within our empirical framework (see Box 2 for more details), we evaluate the contribution of several variables discussed in the previous section in driving investment demand and desired savings and in explaining the relatively low level of long-term real interest rates. Although we do not provide a framework to forecast long-term world interest rates, we provide policy-makers with some insight into those factors likely to be of particular importance.

The variation in the real rate of interest over time has been the subject of several studies. The relatively high level of the real rate of interest in the 1980s has been examined by Barro and Sala-i-Martin (1990). They offer partial answers regarding the determinants of world real interest rates in industrialized countries by measuring the shocks to investment demand against changes in stock market returns, and shocks to desired savings against movements in oil prices. While stock market shocks were used to isolate shifts to expected profitability of investment, the relative price of oil is an indicator of temporary shifts in world income. Their results show that the key elements leading to high world real rates of interest in the period from 1981 to 1986 were favourable stock returns and relatively high oil prices.[20]

Within a broader empirical framework, the recent low level of real long-term interest rates has been studied by the International Monetary Fund (IMF) (2005). They show that the decline in public savings, financial sector reform, and demographic changes are the key factors in explaining movements in savings and investment rates between 1997 and 2004.

In considering how real interest rates are determined, we focus on the interaction between global savings and investment as described earlier (see Box 2 for more details on the empirical estimation and results). Our results are consistent with the literature on the determinants of savings and investment. In particular, increases in oil prices (reflecting temporary factors) represent a temporary negative income shock and appear to cause savings rates to fall. We also find that financial development is an important element in explaining the decline in savings rates, since improved financial sector development can relax borrowing constraints.[21] Demographic changes (for example, an increase in the ratio of elderly to young) are also significant in explaining the global fall in savings rates. Within our empirical framework, the decline in global investment rates is mainly explained by slower growth in the labour force, since a smaller increase in investment is required to equip the more slowly growing labour force with capital, and by lower stock market returns.

Our empirical framework allows us to decompose movements in the long-term world real interest rate. Chart B2 in Box 2 shows, for example, how the various explanatory variables contributed to the change in the world real interest rate over time, measured on the vertical axis. The contribution of each variable in explaining movements in the real interest rate is presented for the periods of interest in Chart 6:

20. Within their empirical framework, the oil-price increase (proxy for temporary reduction in world income) represents a negative shock to desired savings that generates higher real interest rates.

21. This is captured by measures of private credit and domestic credit.

Box 2: Empirical Estimation and Results

To investigate the relative importance of the various determinants of the long-term world interest rate, a data set was compiled for 35 industrialized and emerging economies over the period from 1971 to 2004. The countries included in the data set accounted for 94 per cent of 2004 global real GDP, and the sample covers the full period since the breakdown of the Bretton Woods system and the substantial liberalization of global capital flows. The data set can thus be viewed as a reasonable representation of the global capital market.[1] The definitions of the series are found in the Appendix.

The empirical approach to estimating a real interest rate equation follows Barro and Sala-i-Martin (1990). Savings and investment rates (that is, divided by GDP) for each country are aggregated into world measures. The world savings[2] rate is, by definition, a GDP-weighted sum of country savings rates,

$$s_t = \sum_j s_{tj} \frac{y_{tj}}{y_t},$$

where time is denoted by t and each country is denoted by j.

The world investment rate is calculated in a similar manner. The world savings and investment rates are:

$$S = f(X^s, r)$$

$$I = f(X^i, r),$$

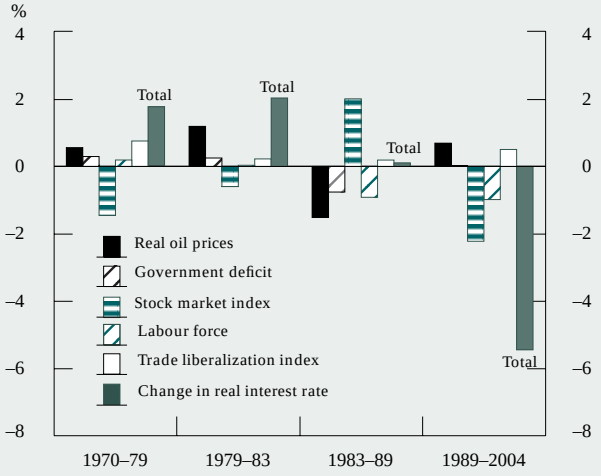
where X^s and X^i are vectors of exogenous global variables that explain shifts in global savings and investment, respectively, and r is the world real interest rate.

Savings and investment levels are jointly determined along with interest rates. In order to understand the impact of shifts in desired savings or investment, we must use the exogenous variables to identify separately the savings and investment functions specified above.[3]

The results suggest that the key factors explaining the decline in savings and investment in the past 25 years are variables that change relatively slowly over time. The variables affecting investment demand are found to include labour force growth, stock market returns, stock market volatility, and economic and financial liberalization. Desired savings is mainly explained by the age structure of the world economy, movements in real temporary income, and government deficits.[4] Other variables, such as the level of financial development (reflected in the ability to mobilize savings, to allocate capital, and to facilitate risk management) also affect savings (Chart B2). For more details on the empirical results, see Desroches and Francis (forthcoming).

Chart B2

Decomposition of Movements in the World Real Interest Rate



Note: The constant, lags of savings and investment, dependency ratio, foreign exchange reserves, and industrial production are omitted from this chart for the sake of simplicity.

1. Our data set omits such oil-exporting countries as Iraq, Iran, Kuwait, and Venezuela, which were significant contributors to global savings in periods of high oil prices, because some of their data were not available.

2. Owing to the Fisher effect, there may be a bias in the measurement of savings, since the fall in savings observed since the early 1990s may be a result of the fall in inflation. IMF (2006), however, show that this inflation bias is small.

3. To identify and estimate both the investment and savings curves, we need to find variables that will shift the savings curve without shifting the investment curve (hence identifying the investment curve) and other variables that will shift the investment curve and not the savings curve (hence identifying the savings curve). An instrumental variable approach is used to control for the endogenous interest rate appearing in both equations.

4. Although not discussed explicitly in this analysis, housing and other durables are considered to be negative savings, rather than household investment.

1970–79, 1979–83, 1983–89, and 1989–2004. A negative contribution of a variable would indicate that this determinant contributes to the decline in the world real interest rate

In considering how real interest rates are determined, we focus on the interaction between global savings and investment.

There are several key findings. First, labour force growth has a particularly important effect on investment. While it explains only a modest portion of the increase in investment demand (and therefore the world interest rate) through 1982, from then on it accounts for a gradual decline in the world real interest rate of about 1.5 percentage points. The oil-price shock had a significant negative effect on savings and contributed to a rise in the real interest rate in 1979 that persisted through 1983. Chart B2 also shows that favourable stock market returns is a key variable accounting for high world real interest rates in the mid-1980s.

Conclusion

The foregoing discussion suggests that the behaviour of the world real interest rate has been affected by a number of key variables that change relatively slowly over time. These variables include labour force growth, which affects investment demand, and the age structure of the world economy, which affects savings. Other variables, such as the level of financial development (reflected in the ability to mobilize savings, to allocate capital, and to facilitate risk management) also influence savings. Since these variables adjust gradually, it is unlikely that they will be a source of significant changes in world interest rates in the near future.

Over the longer term, the analysis suggests that labour force growth is an important determinant of investment demand. Since labour force growth is likely to continue to fall for some time, it might be concluded that this source of downward pressure on interest rates will remain. This effect may be offset, however, by the fact that emerging markets are becoming more capital intensive. Thus, since labour force growth in these economies remains higher than in most industrialized countries, emerging markets are likely to become a more important source of investment demand than in the past.

The behaviour of the world real interest rate has been affected by a number of key variables that change relatively slowly over time.

These conclusions suggest that, over the long term, the interest rate is likely to continue to adjust slowly, reflecting long-term trends. In the short term, however, the empirical analysis implies that unexpected temporary shocks to income, due perhaps to fluctuations in oil prices, could lead to short-term fluctuations in savings behaviour and real interest rates.

Literature Cited

Barro, R. and X. Sala-i-Martin. 1990. "World Real Interest Rates." National Bureau of Economic Research *Macroeconomics Annual* 5 (1): 15–74.

Bernanke, B. 2005. "The Global Savings Glut and the U.S. Current Account Deficit." The Homer Jones Lecture, St. Louis, Missouri, 14 April.

Breedon, F., B. Henry, and G. Williams. 1999. "Long-Term Real Interest Rates: Evidence on the Global Capital Market." *Oxford Review of Economic Policy* 15 (2): 128–42.

Desroches, B. and M. Francis. Forthcoming. "World Real Interest Rates: A Global Savings and Investment Perspective." Bank of Canada Working Paper.

Edwards, S. 1995. "Why Are Saving Rates So Different across Countries? An International Comparative Analysis." NBER Working Paper No. 5097.

Friedman, M. 1957. *A Theory of the Consumption Function.* National Bureau of Economic Research. Princeton, NJ: Princeton University Press.

Gagnon, J. and M. Unferth. 1995. "Is There a World Real Interest Rate?" *Journal of International Money and Finance* 14 (6): 845–55.

International Monetary Fund (IMF). 2005. "Global Imbalances: A Saving and Investment Perspective." *World Economic Outlook* (September): 91–124.

International Monetary Fund (IMF). 2006. "Awash with Cash: Why Are Corporate Savings So High? *World Economic Outlook* (April): 135–59.

Jappelli, T. and M. Pagano. 1994. "Saving, Growth, and Liquidity Constraints." *Quarterly Journal of Economics* 109 (1): 83–109.

Kalman, R. 1960. "A New Approach to Linear Filtering and Prediction Problems." *Journal of Basic Engineering* 82 (Series D): 35–45.

Knight, M. 2006. "Why Have Long-Term Interest Rates Been So Low? Is the Global Interest Rate Cycle Beginning to Turn?" Speech at the National Bank of Slovakia, Bratislava, 12 May.

Mishkin, F. 1982. "Are Real Interest Rates Equal across Countries? An Empirical Investigation of International Parity Conditions." NBER Working Paper No. 1048.

Modigliani, F. 1986. "Life-Cycle, Individual Thrift, and the Wealth of Nations." *American Economic Review* 76 (3): 297–313.

Appendix

Definitions and Sources of Variables

Note: Data are annual unless indicated otherwise. The global variables are real GDP-weighted sums of the 35 countries in our sample. Real GDP (at market exchange rates) was used to calculate the time-varying weights.

Nominal interest rate:	5-year government bonds, quarterly (BIS and IMF)
Inflation:	Consumer price (2000=100) inflation, quarterly (IMF)
Inflation expectations:	Constructed measure of expected inflation, quarterly (see Box 1) (authors' calculations)
Real interest rate:	Nominal interest rate minus expected inflation (authors' calculations)
Real GDP:	Real GDP at market exchange rates (deflator = 100 in 2000) (World Bank)
Savings rate:	Gross domestic savings (private and public) as a percentage of nominal GDP (World Bank and IMF)
Investment rate:	Gross domestic capital formation as a percentage of nominal GDP (World Bank and IMF)
Labour force:	Working-age population (aged 15–64) (World Bank)
Stock market returns:	Nominal returns are computed for December on industrial share prices. Consumer price inflation (December–December) was subtracted from the nominal returns to calculate the real returns (IMF).
Oil prices:	Ratio of oil prices (West Texas Intermediate) to U.S. producer price index (2000=100) (IMF)
Trade liberalization and capital market regulations:	Indexes indicating the extent of capital market regulations and trade liberalization. An increase in the indexes represents a reduction in capital market regulations or an increase in trade liberalization (Fraser Institute)
Dependency ratios:	*Elderly dependency ratio:* population aged 65 and over relative to the population aged 15–64 (World Bank) *Youth dependency ratio*: population aged 0–14 relative to the population aged 15–64 (World Bank) *Total dependency ratio:* population aged 0–14 and 65 and over relative to the population aged 15–64 (World Bank)
Budget deficit:	Ratio of real budget deficit to real GDP. The real budget deficit is the ratio of the nominal deficit to the December consumer price index (IMF, Economist Intelligence Unit, Eurostat, World Bank)[1]

1. Other inflation-adjusted measures of the real deficit are discussed in Desroches and Francis (forthcoming).

Why Monetary Policy Matters: A Canadian Perspective

*Christopher Ragan**

This article provides answers to several key questions about Canadian monetary policy. First, what is monetary policy? Second, why does the Bank of Canada focus on the control of inflation rather than other macroeconomic variables? Third, how do the Bank's actions influence the rate of inflation? And, finally, how can monetary policy deliver genuine and significant benefits to society?

What Is Monetary Policy?

Monetary policy is ultimately about maintaining confidence in the value of money by providing stability in the general level of prices. In Canada, monetary policy is conducted by the Bank of Canada adjusting very short-term interest rates to achieve a growth rate of real output consistent with maintaining a low and stable rate of inflation.

The Bank of Canada's only policy instrument is the target it sets for the overnight interest rate.

The Bank of Canada's only policy instrument is the *target* it sets for the *overnight interest rate*. In Canada, banks lend funds to each other for very short periods at the overnight interest rate, a market-determined rate that fluctuates daily. The Bank of Canada is willing to extend loans to banks at a rate that is set 25 basis points above the target overnight rate. In addition, the Bank will pay interest on any deposits that it accepts from banks, but at a rate 25 basis points below the target overnight rate. By "bracketing" the target overnight rate in this way with a higher lending rate and a lower deposit rate, the Bank of Canada is able to keep the actual overnight rate within a 50-basis point range. Furthermore, by changing its target for the overnight interest rate, the Bank of Canada can alter the actual overnight rate at which banks transact. Such changes in the overnight interest rate lie at the heart of how monetary policy affects the economy.

The Bank's decisions regarding its target for the overnight interest rate also influence the amount of money in the economy, but this linkage is indirect. By changing the overnight interest rate, the Bank of Canada's actions influence the entire spectrum of market interest rates. As these interest rates rise, firms and households reduce their demand for credit from commercial banks. Conversely, as interest rates fall, firms and households increase their demand for commercial-bank credit. With an increase in the amount of credit in the economy, there is an increase in the volume of transactions for goods and services, and thus an increase in the overall demand for money with which to make these transactions. Individual firms and households can satisfy changes in their transactions demand for money by drawing down their savings balances at commercial banks, often in the form of bank notes. Commercial banks occasionally run low on bank notes, and when they do, they can purchase

* Christopher Ragan is an Associate Professor of Economics at McGill University. He was Special Adviser at the Bank of Canada from September 2004 to August 2005. This is a much-condensed version of an article by the same title that can be found on the Bank of Canada's website at www.bankofcanada.ca/en/ragan_paper/index.html. The article was written while the author was the visiting Special Adviser at the Bank; it contains the author's views and should not be taken to represent the official views of the Bank of Canada.

them from the Bank of Canada by selling some of their holdings of government securities. Such a balance-sheet transaction for the Bank involves an increase in assets (government securities) and an increase in liabilities (newly issued bank notes).

Thus we see the connection between the Bank of Canada's target for the overnight interest rate, the amount of money in circulation, and the Bank's balance sheet. Changes in the target overnight rate lead to changes in other market interest rates and thus to changes in the demand for credit, the demand for money, and the demand for bank notes. The Bank accommodates these changes in the demand for bank notes by conducting the required balance-sheet transactions. To some observers, it may appear that the Bank can influence *both* interest rates and the amount of money independently. But this independence is illusory: there is but a single instrument for Canadian monetary policy—the Bank's target for the overnight interest rate.

Why Target Inflation?

Based on a large body of theoretical reasoning and empirical evidence, the policies of most central banks are grounded in two essential propositions:

1. central banks are unable to directly influence variables other than inflation for any sustained period of time; and
2. high inflation is damaging to the economy and costly for firms and individuals.

Both theory and evidence suggest that monetary policy cannot have a systematic and sustained effect on macroeconomic variables other than the inflation rate.

Central banks therefore focus on the control of inflation for two reasons. First, both theory and evidence suggest that monetary policy *cannot* have a systematic and sustained effect on macroeconomic variables other than the inflation rate. Given this limited scope for monetary policy, it would make little sense to adopt other long-run targets, such as the unemployment rate or the growth rate of real output. Second, high inflation is damaging to the economy, in large part because of the uncertainty it generates. Low and stable inflation provides the best overall economic environment in which firms, workers, and consumers can prosper.

The Bank of Canada takes the view that it can make its best contribution to the health of the Canadian economy by maintaining low and relatively stable inflation. To formalize this objective, the Bank, together with the Government of Canada, adopted a system of *inflation targeting* in 1991. In the first three years, the inflation target was reduced gradually, but since 1994, the target has been unchanged, and the Bank has aimed to keep the annual rate of inflation close to 2 per cent and within a range of 1 to 3 per cent.[1] In such an environment of low and stable inflation, Canadian firms and households can make better spending, saving, and investment decisions that lead to steadily rising living standards.

Canada's Inflation Performance and Why It Matters

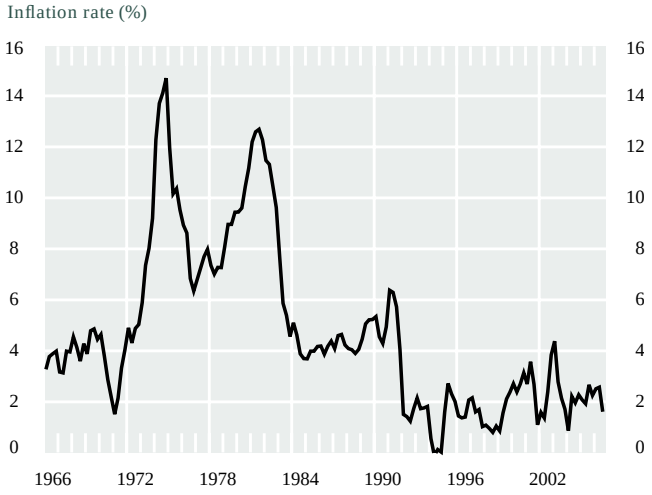
The main problem with inflation is the *uncertainty* it generates in the economy, both for relative prices and for the path of inflation itself. This uncertainty leads households and firms to make decisions they would be unlikely to make in a more certain, low-inflation, environment. Given this connection between inflation and uncertainty, the only effective way to avoid the uncertainty associated with inflation is to reduce inflation itself.

How does inflation interfere with the operation of the price system? In an economy in which the vast majority of transactions are made in private, decentralized markets, and prices are determined by the interaction between buyers and sellers, market prices play a key role in transmitting information and guiding the economy's allocation of resources. The presence of inflation in a market economy—and its associated uncertainty—means that prices can no longer convey this valuable information so clearly, with the result that market outcomes lack the efficiency that would be achieved in a non-inflationary world.

1. The inflation-targeting agreement between the Bank and the Government has been renewed four times since it was first adopted in 1991. The most recent renewal, in November 2006, is scheduled to expire in December 2011. Background documents relating to the current agreement are provided in this issue at pp. 45–59.

Chart 1

Canada's CPI Inflation, 1966–2006



A world of no inflation does not mean a world of complete certainty or unchanging relative prices. Far from it. Relative prices are constantly adjusting in a world in which changes in consumer tastes and the development of new technologies are continually occurring. But this volatility is unavoidable and is standard fare in market economies. The problem with high inflation is that it makes what is already a confusing world even more difficult to understand. Monetary policy aimed at maintaining low and stable inflation can make a genuine contribution to the quality of life by making the decision-making environment clearer for everyone.

Monetary policy aimed at maintaining low and stable inflation can make a genuine contribution to the quality of life by making the decision-making environment clearer for everyone.

An indication of the success of Canada's monetary policy is that inflation is much less newsworthy today than it was during the 1970s, when it was often a headline issue. Whereas inflation was above 14 per cent in 1973 and almost 13 per cent in 1979, inflation over the past decade has remained very close to 2 per cent. It is also true that inflation has been much less volatile in the past decade than it was during the 1970s and 1980s (see Chart 1).

The Stability of Output Growth and Why It Matters

All economies are subject to shocks and thus display fluctuations in the growth rate of aggregate output. These fluctuations are often referred to as *business cycles* even though they rarely display the smoothness and regularity suggested by the term.

Relative stability in output growth is desirable for two reasons. First, relatively smooth output growth makes it more likely that actual output will remain close to *potential output* (the economy's production capacity). With actual output remaining close to potential output, firms and workers avoid situations in which they are pushed to work beyond their limits (*excess demand*) and also avoid situations in which they are idle for considerable periods of time (*excess supply*). Such situations are costly, both for economic and for social reasons. The second reason it is desirable to have relatively stable output growth is that by avoiding situations of excess demand or excess supply, the pressures for inflation to either rise or fall are kept to a minimum. Low and stable inflation can be sustained only if actual output is kept relatively close to potential output.

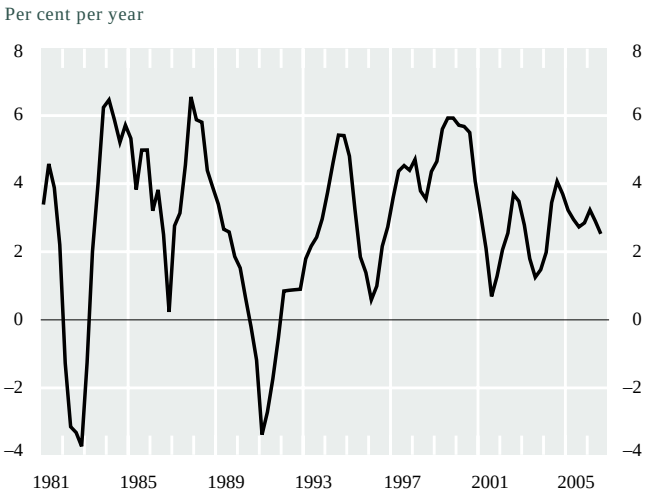
Many economists view an inflation-targeting policy as an output-stabilizing policy.

The Bank of Canada seeks to maintain low and stable inflation by providing some stability to the growth rate of aggregate output. When shocks to demand are expected to cause actual output to rise above or fall below the economy's production capacity, the forward-looking central bank acts to offset these shocks. This is why many economists view an inflation-targeting policy as an *output-stabilizing policy.*

During the 1980s, the annual growth rate of output was usually between –3 per cent and +6 per cent, but on a few occasions was outside of this range. Since 1992, however, output growth has always been in the nar-

Chart 2

Real GDP Growth, 1981–2006



rower range of +1 per cent to +6 per cent. As is clear from Chart 2, Canadian output growth has become more stable since the 1991 adoption of inflation targeting.[2]

Has this reduced volatility in output growth been a consequence of the Bank of Canada's adoption of inflation targeting, or have Canadians simply been lucky in the years following 1991? It is often very difficult in macroeconomics, especially over relatively short periods of time, to determine cause and effect, for the simple reason that many variables are changing simultaneously. However, it is difficult to look back on the past 15 years and conclude that Canada has simply been lucky in avoiding the large numbers of significant shocks that were present in the previous decade. On the contrary, the years following 1991 have seen many shocks, and the Canadian economy has been pushed in various directions. Given this recent history, it seems reasonable to conclude that *some part* of the greater stability in output growth is the result of the Bank of Canada's monetary policy.

Some recent economic research examines this question systematically and reaches the same conclusion.[3] The evidence suggests that the volatility of economic shocks hitting Canada after 1991 increased relative to the earlier period, but that the lower volatility of inflation and output growth was due to an *even greater* improvement in monetary policy. In other words, not only did the Bank of Canada's monetary policy improve following the adoption of inflation targeting in 1991, but it improved enough to *more than offset* an increase in underlying economic volatility, with the overall result being better macroeconomic performance.

How Does Monetary Policy Work?

We have just seen that inflation has been lower, and inflation and real output growth have both been more stable, in the years following the 1991 adoption of inflation targeting than in the preceding decade. How does monetary policy work to accomplish these outcomes?

At the heart of the Bank of Canada's monetary policy is a commitment to maintain low and relatively stable inflation—in particular, to keep the annual rate of inflation close to 2 per cent. The Bank's commitment is essential for influencing firms' and households' *expectations* of inflation. Faced with a shock that threatens to push inflation either above or below the inflation target, Canadian firms and households are confident that the Bank of Canada will act to bring inflation back to the 2 per cent target. This confidence in the Bank's policies comes from the Bank's past record of doing what it claimed it would do: keep inflation low and stable.

The anchoring of inflation expectations is an essential part of successful monetary policy.

When the Bank of Canada has clearly stated objectives, and takes policy actions that affirm those objectives, the result is an increase in its *credibility*. This credibility, in turn, helps to keep expectations of future inflation close to the inflation target—what is sometimes called an *anchoring* of inflation expectations. The anchoring of inflation expectations is an essential part of successful monetary policy.

The complex set of linkages between the Bank of Canada's policy actions and the rate of inflation is

2. For a description of the precise measures of volatility used for calculating inflation and output growth, see the longer version of this article on the Bank's website (www.bankofcanada.ca/en/ragan_paper/index.html).

3. For all references to cited research, see the full-length version of this paper, located on the Bank's website (www.bankofcanada.ca/en/ragan_paper/index.html).

called the *transmission mechanism* of monetary policy. The transmission mechanism is best understood by tracing through the effects of a hypothetical policy decision. Consider, for example, a situation in which a positive demand shock occurs. If the shock persists, output will eventually rise above potential output, and inflation will increase. The Bank of Canada could attempt to prevent this future increase in inflation by raising its target for the overnight interest rate. How would such a policy action help to contain inflationary pressures? There are several steps in the transmission mechanism:

1. The increase in the target overnight interest rate tends to increase longer-term interest rates and, as a result of the subsequent inflow of financial capital to Canada, tends to cause an appreciation of the Canadian dollar.
2. The increase in longer-term interest rates dampens the growth of households' consumption and firms' investment; the appreciation of the dollar dampens the growth of Canadian net exports.
3. Taken together, these effects on consumption, investment, and net exports imply a dampening in the growth of Canadian aggregate demand.
4. The reduction in the growth of aggregate demand leads firms to reduce the growth in their actual output.
5. By keeping actual output from rising above potential output, the pressures for inflationary wage-and-price increases are avoided.

Thus, we see how the Bank of Canada's action to raise its target for the overnight interest rate sets in motion a complicated sequence of cause and effect that helps to keep inflation from rising. But this process takes time. How much time elapses between the Bank's policy action and the other effects, especially the final effect on the rate of inflation?

The Bank of Canada's actions on the overnight interest rate have almost immediate effects on the exchange rate and other interest rates, but the effects on aggregate output build only gradually over time. Current estimates suggest that it takes between 12 and 18 months before most of the effect on aggregate output is realized. The full effect on inflation is not apparent for between 18 and 24 months. And even these estimates are subject to considerable variation; as the late Milton Friedman famously said, the time lags in monetary policy are both long and variable.[4]

The long time lags inherent in the transmission mechanism mean that central banks must be *forward looking* in their policy decisions. Vigilant central bankers are often accused of fighting demons that are non-existent. The problem is that if central bankers delay their policy response until inflation actually appears in the data, it will be too late to have the desired impact. Being forward looking means *anticipating* where the demons will surface and acting in a pre-emptive manner. Furthermore, a central bank that is successful in anticipating future inflationary pressures, and also in taking the appropriate actions to prevent their full realization, can easily be accused of seeing dangers that are not genuine. The truth, however, may be that the dangers were avoided only because of the central bank's vigilance.

Uncertainty and the Need for Information

Given the time lags inherent in monetary policy, the Bank of Canada must be forward looking. But in a world without crystal balls, being forward looking means being uncertain. Indeed, central banks face three different types of uncertainty. First, most economic data are uncertain, being subject to considerable revision several months, and sometimes years, after they are first released. Second, uncertainty exists regarding current and future economic developments in the domestic and world economies. Finally, there is considerable uncertainty about the details of the transmission mechanism itself—that is, uncertainty about the precise nature of the linkages between key macroeconomic variables.

The conduct of monetary policy is therefore best viewed as a problem of *decision making under uncertainty*. The Bank of Canada needs to be forward looking, aware of many possible shocks that may occur in the near future. It must also be aware that economic developments shown to be present by current data may not persist for long, or may in the near future be revealed, through a revision of the data, never to have existed at all. Thus the Bank is forced to perform a precarious balancing act, sometimes taking action in

4. Recent research at the Bank suggests that the effect on inflation may be occurring sooner than previously thought. See the background document on the renewal of the inflation-targeting agreement (p. 53, this issue), particularly the discussion related to Coletti, Selody, and Wilkins (2006).

anticipation of what is likely to happen, while at other times waiting to see what new data confirm to be genuine. Not surprisingly, good judgment based on considerable experience is an essential part of good monetary policy.

The conduct of monetary policy is therefore best viewed as a problem of decision making under uncertainty.

In addition to judgment and experience, the Bank requires a great deal of information in order to conduct the best possible monetary policy. To deal with the uncertainty regarding the various linkages between macroeconomic variables, the Bank conducts a significant amount of *economic research*, both theoretical and empirical, and subjects the results of this research to ongoing testing. The nature of modern economies is such that this job will never be finished, and the complete set of answers will never be known with certainty. Economic relationships depend in important ways on human behaviour, which itself depends on the specifics of time, place, and circumstance.

Dealing with the uncertain developments in the domestic and world economies requires information of a different kind. In order to know what events are occurring and what events are likely to occur in the near future, the Bank assembles and analyzes a great deal of current data. This exercise is often called *current analysis*. The large number of relevant variables, as well as the inherent complexity involved in understanding each individual variable, means that the task of current analysis for any central bank is Herculean. A great many people at the Bank are therefore assigned the task of sifting through and analyzing data on hundreds of variables. Only when the various shocks to the economy are observed and understood can the Bank hope to incorporate that information fruitfully into its overall decision making.

Insights gleaned through economic research are combined with the knowledge embodied in current analysis to conduct the Bank's regular projection or forecasting exercise using its large and complex statistical model of the Canadian economy, the *Terms-of-Trade Economic Model* (ToTEM). Based on the knowledge of economic relationships gained from many years of research, ToTEM is a mathematical representation of the interaction of the various agents in the Canadian economy—households, firms, and governments. The model shows how these economic relationships must evolve over time to be consistent with the underlying assumptions of the agents' behaviour. The model then incorporates past and current data from the Canadian and world economies and projects the most likely future path of Canadian macroeconomic variables.[5]

Only when the various shocks to the economy are observed and understood can the Bank hope to incorporate that information fruitfully into its overall decision making.

For two reasons, the world rarely turns out as the model predicts. First, the model itself, as complex as it is, is nonetheless a highly simplified description of the actual economy. Second, the data that are fed into the model, as good as they are, are also imperfect, and our best predictions regarding what is actually happening in the Canadian and world economies may well turn out to be wrong in some way. Nonetheless, the economic projection provides the Bank of Canada with a logically consistent and well-articulated starting point regarding the future evolution of the Canadian economy, and also a starting point for analyzing the likely future impact of its policy actions. This forecast is then combined with a great deal of other information, including judgments regarding the balance of various risks to the projection, to inform the Bank's policy decisions.

Conclusion

This article has barely scratched the surface of Canadian monetary policy. It has provided a broad outline of what the Bank of Canada does and why. Economies are complicated structures, and we continually strive to learn more about them. Similarly, monetary policy has its impact on the economy through a complex process. As we continue our theoretical research and our analysis of data, our knowledge of this complexity will grow. But so will our questions about it. Given the importance of monetary policy to our well-being, this continued effort is well worth the investment.

5. See Fenton and Murchison (2006).

Literature Cited

Coletti, D., J. Selody, and C. Wilkins. 2006. "Another Look at the Inflation-Target Horizon." *Bank of Canada Review* (Summer): 31–37.

Fenton, P. and S. Murchison. 2006. "ToTEM: The Bank of Canada's New Projection and Policy-Analysis Model." *Bank of Canada Review* (Autumn): 5–18.

All other research cited in this article is referenced in the longer article on the Bank's website: www.bankofcanada.ca/en/ragan_paper/index.html.

A Summary of the Bank of Canada Conference on Fixed-Income Markets, 3–4 May 2006

*Gregory H. Bauer and Scott Hendry, Financial Markets Department**

The Bank of Canada has hosted an annual economic conference since 1990 to present its own research and to promote discussion with leading external researchers on topics of mutual interest and direct policy relevance. The 2006 conference focused on various aspects of fixed-income markets both in Canada and around the world. This topic is important to the Bank for a number of reasons that will be discussed briefly below. The papers and discussions covered such topics as the efficiency of fixed-income markets, price formation, the determinants of the yield curve, and volatility modelling.[1] Other aspects of fixed-income markets will be the focus of ongoing research at the Bank and of future workshops and conferences.

The Bank of Canada's interest in fixed-income markets spans a number of its functional areas of responsibility, which include monetary policy, funds management, and financial system stability and efficiency. Monetary policy concerns the setting of a target for the overnight rate to affect an array of longer-maturity interest rates to achieve a 2 per cent inflation target. The relationship between the yields on short- and long-maturity bonds is known as the yield curve and is the subject of much study. For example, historically, the yield curve seems to have been a good predictor of future real activity and inflation. Thus, a better understanding of yield-curve dynamics could be helpful in contributing to the monetary policy decision-making process. This would involve improving our knowledge of the impact of the policy rate on the total shape of the yield curve.

Funds-management policy covers the Bank of Canada's role as the fiscal agent for the Government of Canada. The Bank manages the cash reserves of the government, issues and manages the domestic-currency debt, and provides policy advice on these and related subjects. In this regard, the Bank has a keen interest in the determinants of liquidity in bond markets and their valuation. In addition, the Bank manages the foreign exchange reserves of the government through a currency- and maturity-matched asset-liability framework that raises money at AAA Government of Canada rates and invests in AAA and somewhat lower-rated fixed-income instruments around the world. An improved understanding of international yield-curve dynamics would allow the Bank to better optimize the structure of the assets and liabilities in the fund, given the constraints under which it operates.

Finally, part of the Bank's mandate is to promote the safety, soundness, and efficiency of the financial system, both in Canada and internationally. Fixed-income markets constitute an integral part of the financial system, and their efficiency and stability are crucial for economic growth and development. The Bank needs to understand better whether Canadian fixed-income markets are stable and are functioning as efficiently as they can by international standards.

The 2006 conference brought together top academics and central bankers from around the world to discuss leading-edge work in the field of fixed-income research.

* We would like to thank David Bolder, Fousseni Chabi-Yo, Antonio Diez de los Rios, Christopher D'Souza, Ingrid Lo, Elena Nemykina, and Jun Yang for their help with the conference and their input for this article.

1. Conference papers and discussions are available on the Bank of Canada's website (www.bankofcanada.ca/en/conference/2006/econ_conf2006.html).

Below is a short summary of each paper and the ensuing discussion. The conference culminated in a panel discussion involving a representative of the Bank of Canada, a representative from the international markets, and a representative of the Canadian financial sector, each giving their unique perspective on the presented research and the field in general.

Session 1: Prices and Liquidity

Liquidity is a fundamental aspect of financial markets. Liquid markets allow participants to trade even large quantities quickly and with little or no impact on prices.[2] The degree of liquidity and its determinants are important factors for the overall level of financial efficiency and stability of a market and are thus of key concern for policy-makers.[3] The two papers in this session examine how certain market characteristics affect liquidity in the market and in the price-determination process.[4]

Amy Edwards (U.S. Securities Exchange Commission), **Mahendrarajah Nimalendran** (University of Florida and U.S. Securities Exchange Commission), and **Michael Piwowar** (U.S. Securities Exchange Commission) examine the reduction in transactions costs observed in the U.S. corporate bond market following the increase in price transparency associated with the new Trade Reporting and Compliance Engine (TRACE). The TRACE system was designed to report and disseminate transactions information on corporate bonds not traded on any exchange. This new system began reporting transactions prices on a subset of bonds in July 2002 and on all TRACE-eligible bonds in October 2004.

The authors investigate which of three competing hypotheses is most likely responsible for the reduction in transactions costs. The first hypothesis suggests that enhanced transparency leads to increased competition among dealers. Investors can observe the prices that others are paying and receiving, and demand the same or better. The second hypothesis suggests that transparency leads to an improvement in the informational efficiency of the market. Trade-based information made available to the greater market limits the ability of informed traders to exploit their private information. Lastly, some researchers have argued that transparency in trades allows investors to determine the relative liquidity of bonds. Since investors prefer higher levels of liquidity, all else being equal, increased transparency may lead to the concentration of liquidity in a set of securities.

The paper by Edwards, Nimalendran, and Piwowar rejects all three of the hypotheses to explain the effect of transparency on transactions costs. They find that price competition among corporate bond dealers increased because of transparency but it did not influence transactions costs. Regarding the second hypothesis, transactions costs are found to be positively related to the probability of trading with an informed investor (the inverse of a measure of informational efficiency). However, the change in transparency had no effect on the degree of informational efficiency. Finally, evidence is found that transactions costs are negatively related to measures of liquidity concentration, but that liquidity concentration in the bond market was unaffected by the transparency changes. As such, the question is still open regarding the mechanism through which transparency enhancements can lower transactions costs in the corporate bond market.

In his discussion, **David Goldreich** (University of Toronto) emphasized the importance of the question being addressed: why exactly does increased price transparency lower transactions costs? While the three leading hypotheses were all rejected by the data, he argued that this is still preliminary work and that further examination of the question and of each hypothesis is still required. Goldreich made the point that the measures used in the paper for competition, liquidity concentration, and informational efficiency are all proxies and that alternative indicators should be investigated.

Christopher D'Souza (Bank of Canada), **Ingrid Lo** (Bank of Canada), and **Stephen Sapp** (University of Western Ontario) emphasize that it is important to account for the structure and organization of a financial market when investigating how prices and the provision of liquidity evolve over time. In Europe, market-makers using the MTS[5] electronic platform for interdealer trading of government securities must continuously

2. An alternative definition of a liquid market is that the price reverts quickly to the initial level after a trade.

3. See Bauer (2004) for an overview of the concept of efficiency.

4. See Zorn (2004) for a summary of a previous Bank of Canada workshop on these topics.

5. MTS—Mercato Telematico dei Titoli di Stato—is the dominant electronic platform for interdealer trading of government securities in Europe. Government bonds are traded on two platforms: EuroMTS and MTS domestic markets. The former is the electronic market for euro benchmark bonds, while the latter lists the whole yield curve of individual countries. Both platforms are electronic limit-order books in which dealers place limit and market orders. Dealers can see orders with the five best prices on both sides of the market.

post buy and sell limit-orders within a maximum bid-ask spread, for a minimum quote amount, for a given period of time each day. These provisions are collectively known as the "liquidity pact." In Canada, a large proportion of government securities trading takes place via interdealer brokers. While there are no formal quoting obligations placed on the dealers in Canada, they commit themselves to trade continuously in the market by posting a bid and an ask price for each government security.

The authors find that, for short-term government securities, the price and liquidity dynamics for Canadian securities are similar to those of European securities despite the large differences in institutional structure. This, in turn, suggests that a liquidity pact in Canada may not improve market quality. Using a vector-autoregression model with prices, order flow, order imbalances, and bid-ask spreads, the authors find that order flow has a permanent and positive impact on price, while spreads are informative and have a long-run impact on prices only in Canada. The fact that spreads do not convey information in the European market is attributed to the differences in market structure, particularly the presence of the liquidity pact in MTS. Both markets are found to be relatively efficient, but there is some evidence that the European market is slightly more efficient in that it does reflect fundamental information in a shorter amount of time.

In his comments, **Joshua Slive** (HEC Montréal) identified two different questions addressed in the paper: (i) do signed order flow and/or order imbalance explain movements in prices; and, (ii) what are the linkages between liquidity and price formation? Slive suggested that a structural estimation approach would be preferable to a vector autoregression if the first question were the focus of the paper, since the demand and supply of liquidity cannot be considered to be independent. Slive argued that the paper should instead focus directly on the linkages between liquidity and price discovery, and on whether the speed of price formation varies with market liquidity. The discussant also recommended that the authors develop a theoretical model to motivate the empirics of the paper.

Session 2: Links between Cash and Derivatives Markets

Fixed-income instruments trade in both cash (or spot) and derivatives markets. The growth of derivatives markets in recent years has proceeded faster than the research done to understand their characteristics and functioning. With their increasingly important role, policy-makers are looking to improve their understanding of how these markets operate and how they are linked with other financial markets and the real economy.

Bryan Campbell (CIRANO, Concordia University) and **Scott Hendry** (Bank of Canada) examine the price-discovery process for the 10-year government bond markets in both Canada and the United States. Their work compares the contribution to price discovery of both the futures market and the underlying spot market for the 10-year government bond in each country. In general, the futures market dominates the price-discovery process with approximately 70 per cent of price discovery occurring in both the Canadian and the U.S. futures markets. These results are remarkably similar across the two countries despite the large differences in the sizes of their markets. Daily changes in the price-discovery process are found to be related, in part, to bid-ask spreads and trading volumes, but much remains unexplained.

In his discussion, **Bruce Mizrach** (Rutgers University) emphasized that one must be wary of these price-discovery information shares because they are based on reduced-form models that include unobserved components. While such models represent a useful summary statistic of the relative importance of different markets, he recommended that future work should concentrate instead on the direct estimation of the underlying structural model to try to get a clearer picture of the actual price-discovery process.

Prachi Deuskar (New York University), **Anurag Gupta** (Case Western Reserve University), and **Marti Subrahmanyam** (New York University) examine the effect of liquidity on interest rate options. Their paper identifies a systematic common factor that drives liquidity, across both option maturities and strike rates. They find that, contrary to results for most other markets, liquidity has a negative effect on option prices—illiquid options trade at higher prices relative to liquid options after controlling for other variables. The common liquidity factor is itself driven by the changes in uncertainty in the equity and fixed-income markets. An increase in uncertainty in the equity and bond markets appears to cause a negative liquidity shock in the interest rate options market as traders attempt to manage their risk. It is not the expectations about inflation or growth that seem to affect the liquidity in interest rate options—it is the uncertainty about

these expectations that affects the liquidity in this market. There is still, however, a large amount of variation in option-market liquidity that is yet to be explained. Further work should examine how the liquidity of this market behaves during crisis events and how liquidity effects co-move across the underlying asset market and the derivatives market.

Haitao Li (University of Michigan), in his comments, wondered whether the results would be different if exchange-traded interest rate options, for which a much richer set of microstructure information is available, were used instead of over-the-counter (OTC) market prices. He also made the point that it would be good to consider other options markets so that measures of liquidity other than just the bid-ask spread could be examined. Also, given that the bid-ask spread is the only measure of liquidity available, a better understanding of how spreads are set by the market-makers would be very important, especially for understanding what drives the common liquidity factor.

John Kuszczak Memorial Lecture

Kenneth Singleton (Stanford University and NBER) delivered the 2006 John Kuszczak Memorial Lecture,[6] "Discrete-Time Dynamic Term Structure Models with Generalized Market Prices of Risk." This joint work with **Qiang Dai** (University of North Carolina) and **Anh Le** (New York University) develops a rich class of discrete-time, non-linear dynamic term-structure models (DTSMs) for which closed-form solutions can be found for zero-coupon bond yields and their conditional densities. This modelling framework allows much more freedom in specifying the dependence of the market price of risk on the vector of state variables. In turn, this permits the empirical investigation of much richer specifications of risk premiums than have previously been considered. Much of the current literature in this field, for example, rules out the possibility of time-varying second moments (i.e., risk) in macroeconomic models. However, the DTSMs developed in this paper allow for time-varying second moments as well as for very flexible forms of non-linearity in the conditional means of the state variables. Another advantage of this framework is that, instead of having to use approximation techniques, the models can be estimated directly, since the exact likelihood functions are known. In a highly non-linear empirical model, the authors show that, in comparison to existing linear models, they can significantly improve the model's statistical fit as well as its out-of-sample forecasting performance.

Session 3: High-Frequency Analysis of the Yield Curve

Much of the existing literature on the yield curve has been completed using lower-frequency (e.g., monthly) data. This can make it difficult to identify precisely fundamental relationships and the effects of specific shocks that occur during the month. The papers in this session use high-frequency, intraday data to examine the dynamics of the yield curve in response to order flow as well as the release of information to the marketplace.[7] These papers contribute to our understanding of the level of informational efficiency in the market (i.e., the ability and speed at which the market processes new information and moves prices to their new equilibrium values).

Paolo Pasquariello (University of Michigan) and **Clara Vega** (University of Rochester and Board of Governors of the Federal Reserve System) consider how order flow in government bond markets moves daily bond yields. The paper incorporates two realistic market frictions—information heterogeneity and imperfect competition among informed traders—and a public information signal into a trading model to study the role played by private and public information in the price-formation process in the 2-, 5-, and 10-year U.S. Treasury bond market. Consistent with the implications of the model, they find that a high dispersion of beliefs across informed traders is associated with less-aggressive trading. In addition, unanticipated order flow accounts for a larger portion of bond-yield changes when the dispersion of beliefs among market participants is high, during non-announcement days, and when the public-signal noise is high. Finally, it is found that bond-yield changes and order flow are most sensitive to Nonfarm Payroll Employment announcements.

Kathy Yuan (University of Michigan) commented on this paper by pointing out that there were certain implications of the theoretical model that were not explored in the data. For instance, the correlation of agents' information endowments could be positive

6. This annual lecture was inaugurated in 2003 in memory of John Kuszczak, a Bank of Canada researcher who died in 2002.

7. News releases are public information; in contrast, order flow can contain private information that is not available to all market participants.

or negative, with differing effects on prices, but the empirical tests only consider the positive case. It could therefore be important empirically to differentiate between positive and negative news days. There could also be an asymmetric order-flow impact following good and bad news because of short-sale and borrowing constraints. She also pointed out that order flow from one bond maturity (e.g., 5 years) could also affect yield changes in other maturities (e.g., 2 and 10 years) in addition to its own.

Michael Fleming (Federal Reserve Bank of New York) and **Monika Piazzesi** (University of Chicago, NBER, CEPR) assess the effects of Federal Open Market Committee (FOMC) announcements on the term structure of U.S. Treasury securities using high-frequency, intraday data instead of the lower-frequency data (e.g., daily, weekly, monthly) typically used in the literature. The analysis shows that the yields are quite volatile around FOMC announcements, even though the average effects of surprises in the target for the federal funds rate are fairly modest. Yield changes seem to depend not only on the surprises themselves but also on the shape of the yield curve at the time of the announcement, representing market participants' time-varying concerns about inflation. For example, a positive FOMC surprise while the yield curve is particularly steep, possibly after a period of expansionary monetary policy, may actually lower longer-term yields through a reduction in inflation expectations. The authors also find that the reaction to FOMC announcements is sluggish, largely as a result of previous rate changes that occurred outside of regularly scheduled meetings. This implies that profitable trading opportunities exist, but it is shown that trading costs largely eliminate any potential profits. Finally, the behaviour of market liquidity around FOMC announcements is quite similar to that found for other macroeconomic news announcements in that liquidity is withdrawn from the market before the announcement. However, announcements that come out slightly later than expected are associated with both longer episodes of illiquidity and greater illiquidity before the announcement. Uncertainty over the announcement time may be decreasing market liquidity around announcements.

In his discussion, **Eric Swanson** (Federal Reserve Bank of San Francisco) urged the authors to consider the effects of the content of FOMC announcements instead of just the timing. He made the point that the FOMC rate decision is no longer the true surprise variable. Instead, most new information is contained in any communication regarding the future path of policy rates. The discussant also made the point that different sources of information on the timing of FOMC announcements can yield quite different results, so each alternative should be investigated.

Session 4: No-Arbitrage Pricing and Strategies

An arbitrage trade is one where an investor can buy low and sell high to obtain an instantaneous, risk-free profit. Since there are no "free lunches" in well-functioning, competitive markets, the condition that rules out arbitrage trades puts limits on the levels of prices of different assets at a point in time. In the academic literature on the term structure, it has been shown that imposing this "no-arbitrage pricing" on the models of the yield curve has improved their forecasting abilities (Ang and Piazzesi 2003). The papers in this session use the no-arbitrage framework for other purposes.

The paper by **Ruslan Bikbov** (Columbia Business School) and **Mikhail Chernov** (Columbia Business School) re-examines the relationship between monetary and fiscal policies and the yield curve. It is now recognized that the cross-section of bond prices contains three "statistical" factors: level, slope, and curvature. In this paper, the authors use a no-arbitrage framework to include macroeconomic variables along with the statistical ones. They use an econometric approach that maximizes the ability of the macroeconomic factors to explain the yield curve. They show that the macroeconomic variables and their lags can explain 80 per cent of the variation in the short rate (level), 50 per cent of the slope of the yield curve, and 68 per cent of the 10-year term premium. In addition, the unanticipated shocks to the statistical factors are strongly correlated with three factors: the AAA credit spread, which measures a "liquidity effect"; a measure of the money supply; and the growth of the government public debt (a "fiscal policy" shock). This indicates that the yield curve contains information about a wide variety of macroeconomic factors and that the simple models of the term structure currently in use will have to be augmented to contain these factors.

Michael Gallmeyer (Texas A&M University) discussed how this approach could help to explain how monetary policy affects the economy. In current macroeconomic models, a Taylor rule that relates the short-term interest rate to the state of the economy is used to explain the behaviour of the central bank. Gallmeyer noted that

other, longer-term interest rates would also contain useful information about central bank policies. The results of the Bikbov and Chernov paper reinforce this view. Gallmeyer suggested that the authors consider looking at business cycle regimes where recessions have a significant influence on the relationship between monetary policy and output.

The paper by **Jefferson Duarte** (University of Washington), **Francis Longstaff** (UCLA), and **Fan Yu** (UC Irvine) examines the risk-return trade-off for a number of fixed-income "arbitrage" strategies. These are not, as the authors clearly note, actually arbitrage opportunities, but rather, market vernacular for fixed-income trading strategies, some of which are relatively complex. All of the strategies, irrespective of their complexity, are based on the idea of exploiting deviations of market prices from theoretical model-based prices. The authors apply their approach to the swap, Treasury, mortgage, corporate bond, and fixed-income derivatives markets. They note that some commentators have viewed the payoffs on these strategies as "picking up nickels in front of a steam-roller": investors can make many small profits but every so often are crushed by the market and earn large negative returns. The authors find, however, that some of these strategies can earn large and significant risk-adjusted returns.

David Bolder of the Bank of Canada provided the discussion. He noted that the paper had some implications for the Bank's financial system function. If many fixed-income investors are hit by the steamroller at the same time (i.e., many investors earn large negative returns), this could lead to instability as they trade to get out of the positions. Thus, central bankers should use this analysis to determine the degree of correlation among the positions in the various markets.

Session 5: Multi-Country Models of the Term Structure

Canada is often viewed as the typical "small, open economy." As a result, the Bank of Canada has an interest in how best to implement monetary policy in a country where the yield curve is subject to international influences. In most industrialized countries, the central bank is able to move the short end of the yield curve. What matters for aggregate demand, however, are long-term yields and, in an open economy, exchange rates. A multi-country model of the yield curve helps to explain how the movements at the short end translate into changes in longer-term yields and the exchange rate.

The paper by **Antonio Diez de los Rios** (Bank of Canada) proposes an essentially affine model of the joint behaviour of interest rates and the exchange rate in two countries. In the model, movements in these variables are related in such a way as to preclude the existence of arbitrage opportunities. The term structures and the expected rate of depreciation of the exchange rate are functions of both the domestic and foreign short-term interest rates. The author finds that imposing the no-arbitrage restrictions in the estimation of the model produces exchange rate forecasts that are superior to those produced by time-series methods such as a random-walk model or a vector autoregression. This is a notable result, given that the random-walk model has proved very difficult to beat in forecasting exchange rates.

In his discussion, **Adrien Verdelhan** (Boston University) viewed the model's ability to combine both term-structure and exchange rate data to yield better forecasts as promising. He suggested that the author examine further the causes of the superior forecasting ability. In particular, including terms that would help to explain the volatility of the currency would also help the model.

Fousseni Chabi-Yo (Bank of Canada) and **Jun Yang** (Bank of Canada) study the joint dynamics of bond yields and macroeconomic variables in a New Keynesian, small, open economy. This approach allows the authors to examine the impact of domestic and foreign shocks on the yield curve. Using Canadian and U.S. data, the authors find that U.S. macroeconomic shocks contribute to a larger proportion of the variation of the Canadian yield curve and the yield premium than do Canadian macroeconomic shocks. It is also shown that Canadian monetary policy and U.S. aggregate demand shocks explain most of the variations of the expected excess holding-period returns of short- and medium-term bonds. In contrast, the expected excess holding-period returns of long-term bonds are mainly driven by U.S. aggregate supply shocks.

In his discussion, **Sen Dong** (Columbia University) acknowledged the importance of explaining bond risk premiums in a model with microeconomic foundations. He emphasized, however, that the inflation-risk premium should be taken into account in the aggregate-demand dynamics. He also pointed out that the pricing mechanism used in the paper has to be consistent with the consumer's utility-maximizing problem. In addition, he suggested a richer specification for the

exchange rate dynamics and a more efficient estimation technique.

Session 6: Volatility and the Term Structure

Most of the recent term-structure literature has focused on the determinants of the levels of rates along the yield curve. However, central bankers also have a keen interest in the volatility of interest rates. The Bank of Canada, for example, has a policy role in ensuring a stable and efficient financial system. To understand stability and efficiency, the Bank needs a good understanding of the drivers of volatility.

Jefferson Duarte (University of Washington) attempts to determine if hedging activity related to the mortgage-backed-security (MBS) market has any impact on volatility in interest rate markets (i.e., treasury, swap, and associated derivatives). MBSs are difficult to price, since they contain an option that is generally exercised in the event of falling interest rates: when interest rates fall, U.S. homeowners may refinance ("prepay") their mortgages (without paying a penalty), leading to large cash inflows to MBS holders. These investors attempt to control this prepayment risk through the purchase and sale of swaps, treasuries, and related interest rate securities. The way in which this risk is hedged may lead to an increase in the volatility of U.S. Treasury bonds, or their derivatives, or both. Duarte provides a theoretical and empirical analysis of the links between prepayment risk and volatility in fixed-income markets. He finds that including prepayment information in the model improves interest rate forecasts, suggesting that MBS-hedging activity does, in fact, lead to increases in actual interest rate volatility.

In his discussion, **Daniel Smith** (Simon Fraser University) noted that, even after this very thorough analysis, a number of unanswered questions remain in this area. In particular, the relationship between volatility in U.S. Treasury bonds and the volatility of their derivatives is still not completely understood. For instance, the model used to estimate volatility in the Treasury bond market could be expanded to include regime-specific volatility factors.

In the second paper in this session, **Caio Almeida** (Ibmec Business School), **Jeremy J. Graveline** (Stanford University), and **Scott Joslin** (Stanford University) note that, in the existing literature, estimates of the term-structure models are made mainly with yield data. Interest rate options may contain information about this risk premium because their prices are sensitive to the volatility and market prices of the risk factors that drive interest rates. They include the prices of interest rate options when estimating three-factor affine term-structure models and then compare the performance of the estimated models with and without the options. The paper shows that models with options predict excess long-term rates better than those without, in both in- and out-of-sample tests. Thus, it needs to be recognized that prices of options and other derivative instruments that are sensitive to volatility will contain additional information about the future of the economy.

Christopher Jones (University of Southern California) noted that, by including interest rate options, the model in the paper improves both the ability to explain bond market volatility and the ability to forecast yield levels. This is so because existing models are created to explain the cross-section of bond prices at a given point in time, while an understanding of volatility requires an analysis of bond prices across time. By including the interest rate derivatives, the model is able to capture the time series of the data much better.

Session 7: "Might as Well Jump!"

Recently, there has been a renewed interest in examining the effects of news on financial-asset prices. In this literature, researchers have shown that news about macroeconomic variables is generally swiftly processed by financial market investors, leading to a jump, or discontinuity, in the path of the asset's price. It remains an open question, however, as to how to include jumps in formal DTSMs.

The paper by **George J. Jiang** (University of Arizona) and **Shu Yan** (University of Arizona) examines some fundamental questions in term-structure modelling. First, they examine the causes of jumps in interest rates. Second, they examine what causes the speed of these news events to vary over time. To accomplish these aims, they develop a model of the term structure of interest rates that includes jumps. The paper shows that jumps are related to movements in the short-run interest rate and macroeconomic shocks. This will be helpful in analyzing the effects of monetary policy shocks on the bond market.

Peter Christoffersen (McGill University) detailed a number of technical suggestions for the model. These mostly deal with the tricky issue of modelling bond-market volatility while including jumps. In addition,

the estimation of the models remains challenging. He suggested comparing the results of this more advanced model with some of the simpler benchmarks that have been developed in the literature. This would allow the reader to assess the value added of this paper more directly.

The main point of the paper by **Torben G. Andersen** (Northwestern University and NBER) and **Luca Benzoni** (University of Minnesota) is that the existing literature reflects a poor understanding of volatility in fixed-income markets. In particular, the standard affine term-structure model does not capture the volatility dynamics that are evident in the data. The estimated volatility variable from these models is not nearly as persistent as the volatility measured using the time series of bond prices. Thus, interest rate volatility cannot be extracted from the cross-section of bond yields in the U.S. Treasury market. This implies that hedging the risk of interest rate volatility by trading a portfolio of bonds will yield a very poor hedge, suggesting that investors need to use other instruments to manage the risk inherent in their portfolios.

Michael Johannes (Northwestern University) noted that there are three ways to model fixed-income volatility: the volatility that arises from the term-structure model; the volatility inherent in option prices; and the volatility that can be obtained from time-series data. The problem is that the three ways of measuring volatility may yield very different results. He suggested that Andersen and Benzoni's model may need to be adapted to account for jumps. If volatility does contain a systematic jump component, this may greatly complicate the hedging problem for investors.

Panel Discussions: Alternative Perspectives on Fixed-Income Markets

David Longworth (Bank of Canada) focused on the challenges in fixed-income research, on the policy implications of the conference papers for the Bank of Canada's functions, and on some areas for future research. The main challenge for researchers and policy-makers is to incorporate variables that are omitted from the models commonly used in the fixed-income literature, including domestic macroeconomic variables, foreign prices and macroeconomic variables, variables from other markets, and volatility, or jumps. The papers in the conference each made a contribution towards incorporating some of this missing information. Other challenges facing researchers include properly modelling the stability of relationships, making comparisons across markets and countries, and conducting welfare analysis via general-equilibrium models.

Longworth then outlined how the conference papers contributed to the Bank's understanding of three of its main functions: financial system stability and efficiency, monetary policy, and funds-management policy. The papers on liquidity and the price-formation process improve our understanding of the efficiency and stability of financial markets in Canada and internationally. Several papers offered insights on the extraction of information from interest rates based on current and future economic fundamentals that could be useful in the formation of monetary policy. Other papers emphasized that the communications strategy and the manner in which monetary policy announcements are made are important for the transmission of monetary policy. Finally, several of the papers offered interesting insights on various aspects of the Bank's debt-management responsibilities for the federal government. Detailed models of the level and volatility of the yield curve are necessary for building a debt-management policy to reduce funding costs for the government.

Longworth concluded that fixed-income research seems to be beginning to deal with some of the challenges that have existed for some time with respect to omitted variables, but that much more remains to be done, especially with respect to examining the stability of the estimated relationships.

Mark Caplan (BMO Nesbitt Burns) spoke from a market practitioner's perspective about the ways in which economic and market research have been used in their global trading businesses and about the types of research that should receive greater focus. He emphasized that financial markets-based research underlies everything they do as providers of financial market services. At a very basic level, research has provided the information necessary for the growth of an efficient, liquid, and well-understood capital marketplace. This information allows participants to transact confidently in fixed-income markets. Predictive models also have an important role, for both clients and BMO's own proprietary trading desks, in predicting future prices. Quantitative research is also important for model-based valuation of a wide range of new products, especially as the complexity of the market grows. Most new product advances—structured notes, hybrid derivatives, credit derivatives, inflation-linked securities—have been possible only because of

research around option pricing and measurement of volatility or correlation. Finally, the risk-management arm of financial services firms are big users of modern modelling and valuation techniques to manage their risk and the associated regulatory capital.

In looking to future research, Caplan made the point that the fixed-income market has recently experienced—and will continue to do so—considerable change, and that these developments are all worthy of further study. The first change is a splitting of the market such that practitioners now perceive it as two distinct markets: one for rates and another for credit. Owing to the growth in liquidity, transparency, and product development in the credit derivatives markets, participants are now able to manage their credit-risk exposure separately from their view of the future path of administered rates, the shape of the yield curve, and underlying macroeconomic forces. There have also been changes to the underlying functioning of the market (in both liquidity and efficiency) that provide opportunities for interesting research. The growth of China and increased globalization are two important factors affecting capital flows. Similarly, advances in electronic trading and the growth of hedge funds are two factors that have had a big effect on market structure. Finally, Caplan made a call for more research on Canada specifically.

Pierre Collin-Dufresne (Goldman Sachs Asset Management, University of California Berkeley, and NBER) provided a survey of the dynamic term-structure literature. Using a DTSM in the real world requires that a number of steps be completed. The user must write down a rather complex multi-factor model with many parameters. He or she must then derive analytic solutions for the prices of bonds or derivatives securities as well as specifying a risk-premium function. The user must then use complex empirical techniques to estimate the model and determine its predicted values for bond prices.

Despite all this structure (or perhaps as a result of all this structure), the models have not fit the data along many dimensions. As a result, researchers have turned to other sources of data for help. As shown above, using information from the derivatives markets helps to model volatility better. Using macroeconomic data to put more structure on the factors helps interpret the results. Using high-frequency data can aid in the interpretation of shocks.

Collin-Dufresne noted that DTSMs have the potential to be useful in several real-world applications. The first is to help investors in fixed-income markets. The problem with these models, however, is that the parameters and the state variables appear to change over time. This would lead to unstable portfolio holdings, resulting in higher transactions costs. In addition, as noted above, the models do not estimate the volatility (i.e., risk) of the portfolios well. As a result, DTSMs are not widely used in fixed-income portfolio management.

The second application where DTSMs may be useful is in the pricing and hedging of derivative securities. DTSMs price derivative securities by no-arbitrage arguments where the price of the derivative is equal to that of a basket of bonds. Thus, investors could, in theory, use these models to hedge their positions in derivatives. Unfortunately, the factors driving volatility in the bond markets do not appear to be the same as those driving volatility in the derivatives markets. As a result, more work is required to determine the precise causes of volatilities in the two markets.

The third application is in linking prices in the bond markets to macroeconomic variables. Using the bond market to extract more information about the state of the economy would be useful for central bankers and others. Collin-Dufresne noted that the models yield good information about the current state of the economy, but that what is of interest is its future state.

The final application is to use the models to learn more about the risk-return trade-off in the markets, which is the central question faced by any investor in these markets. Unfortunately, the price of risk yielded by DTSMs is often complex, highly volatile, and large. This makes identifying the trade-off between risk and expected return difficult.

Collin-Dufresne concluded by noting that academics, investors, and central bankers will have to resolve these issues in the future to make DTSMs more useful in practice.

Literature Cited and List of Conference Papers

The conference papers cited in this article are also available on the Bank's website at www.bankofcanada.ca/en/conference/2006/econ_conf2006.html.

Almeida, C., J. Graveline, and S. Joslin. 2006. "Do Options Contain Information about Excess Bond Returns?"

Andersen, T. and L. Benzoni. 2006. "Can Bonds Hedge Volatility Risk in the U.S. Treasury Market? A Specification Test for Affine Term Structure Models."

Ang, A. and M. Piazzesi. 2003. "A No-Arbitrage Vector Autoregression of Term Structure Dynamics with Macroeconomic and Latent Variables." *Journal of Monetary Economics* 50: 745–87.

Bauer, G. 2004. "A Taxonomy of Market Efficiency." *Bank of Canada Financial System Review* (December): 37–40.

Bikbov, R. and M. Chernov. 2006. "No-Arbitrage Macroeconomic Determinants of the Yield Curve."

Campbell, B. and S. Hendry. 2006. "A Comparative Study of Canadian and U.S. Price Discovery in Ten-Year Government Bond Markets."

Chabi-Yo, F. and J. Yang. 2006. "Estimating the Term Structure and Macro Dynamics in a Small Open Economy."

Dai, Q., A. Le, and K. Singleton. 2006. "Discrete-Time Dynamic Term Structure Models with Generalized Market Prices of Risk."

Deuskar, P., A. Gupta, and M. Subrahmanyam. 2005. "The Drivers and Pricing of Liquidity in Interest Rate Options Markets."

Diez De los Rios, A. 2006. "Can Affine Term Structure Models Help Us Predict Exchange Rates?" Bank of Canada Working Paper No. 2006–27.

D'Souza, C., I. Lo, and S. Sapp. 2006. "Price Formation and Liquidity Provision in Short-Term Bond Markets."

Duarte, J. 2006. "The Causal Effect of Mortgage Refinancing on Interest-Rate Volatility: Empirical Evidence and Theoretical Implications."

Duarte, J., F. Longstaff, and F. Yu. 2006. "Risk and Return in Fixed Income Arbitrage: Nickels in Front of a Steamroller?"

Edwards, A., M. Nimalendran, and M. Piwowar. 2006. "Corporate Bond Market Transparency: Informational Efficiency, Competition, and Liquidity Concentration."

Fleming, M. and M. Piazzesi. 2006. "Monetary Policy Tick-by-Tick."

Jiang, G. and S. Yan. 2006. "Affine-Quadratic Term Structure Models—Toward the Understanding of Jumps in Interest Rates."

Pasquariello, P. and C. Vega. 2006. "Informed and Strategic Order Flow in the Bond Market."

Zorn, L. 2004. "Bank of Canada Workshop on Regulation, Transparency, and the Quality of Fixed-Income Markets." *Bank of Canada Financial System Review* (June): 39–44.

Perspectives on Productivity and Potential Output Growth

A Summary of the Joint Banque de France/ Bank of Canada Workshop, 24–25 April 2006

Gilbert Cette, Economic Forecasting and Analysis Directorate, Banque de France, and Don Coletti, International Department, Bank of Canada

Held in Enghien, France, on 24–25 April 2006, this joint workshop[1] brought together researchers to quantify and better understand differences in productivity and potential output growth among industrialized countries. The workshop was attended by some 30 economists, mainly from central banks. In this short summary of the proceedings, the authors highlight the findings around the three main themes.

Central banks are keenly interested in productivity and potential output for a number of reasons.[2] Productivity directly affects firms' marginal cost of production, which is a key driver of prices. Productivity is also a key determinant of potential output, and short-run deviations of actual output from potential output, known as the output gap, are a useful indicator of future inflationary pressures. Productivity differentials across countries also have important implications for the behaviour of the real exchange rate. Specifically, economic theory suggests that if productivity gains against foreign countries are concentrated in the tradable sector then, everything else being equal, the home country's real exchange rate will tend to appreciate. Lastly, and most importantly, a nation's productivity is the prime determinant of its real incomes and standard of living.

The purpose of the workshop was to bring together researchers to quantify and better understand differences in productivity and potential output growth among industrialized countries. The research presented focused on three main themes: (i) estimating potential output; (ii) productivity and growth; and (iii) institutions, policies, and growth. Eleven papers were presented; designated discussants commented on each paper; and questions were taken from the floor. Susanto Basu of Boston College served as *rapporteur* and gave his perspective on recent academic research that examines productivity growth.

This article is a short summary of the proceedings. Each section begins with an introduction to the issues and a brief summary of the research presented. Some additional details are then offered for each paper.

Theme 1: Estimating Potential Growth

The first group of papers focused on estimating potential output growth (or, alternatively, the output gap) for several industrialized countries. Three of the papers employed statistical techniques to estimate potential

1. The full text of the conference papers, and some of the discussants' presentations, are available on the Bank's website at www.bankofcanada.ca/en/conference_papers/france2006/papers.html.

2. Productivity is a measure of how efficiently an economy transforms its factors of production (e.g., labour and capital) into goods and services. Potential output is the level of production compatible with an absence of price pressures in the goods and labour markets, which is a condition for stable inflation.

output using a production-function approach, while the remaining two papers examined potential output using dynamic stochastic general-equilibrium (DSGE) models.

Despite significant measurement problems, some elements of the analysis seem to be fairly robust. In particular, the estimates of potential output growth presented at the workshop suggest sizable differences between the main industrialized countries. Over the past decade, for example, it is estimated that the United States and Canada have experienced potential output growth in the neighbourhood of three per cent per year.[3] At the other end of the spectrum, Italy and Japan experienced estimated potential output growth averaging only about one per cent per year. The research also suggests that the substantial differential in potential growth between countries reflects differences in labour productivity and in the growth of the labour force.[4] For over a decade, the United States, for example, has been experiencing labour productivity growth that is high relative to recent historical levels and much more vigorous than in most other industrialized countries. In addition, labour force growth in Europe and in Japan has fallen behind the pace in North America.

The work done with the DSGE models also proved to be quite instructive. One of the lessons learned from the workshop was that imposing additional restrictions on data that are generated by a well-specified economic model can lead to an improvement in estimates of the output gap.

The first paper in the session, by **Tommaso Proietti** (University of Rome) and **Alberto Musso** (European Central Bank, ECB), combined a traditional production-function approach to estimating potential output with a Phillips curve relationship to estimate and analyze the euro area's potential output and its components. A key finding was that there has been a significant slowdown in the growth in trend labour productivity in the euro area, from 3.7 per cent in the 1970s to 2.5 per cent in the 1980s and to 1.9 per cent in the 1990s. Since 2000, the slowdown has been even more pronounced, with growth in trend labour productivity estimated to have averaged only 0.7 per cent. In addition, potential output growth has also suffered, owing to the weaker growth in the working-age population.[5] These factors have been partially offset by a rise in the trend labour force participation rate, resulting mostly from the increased participation of women. On net, the authors estimate potential output growth at about 1.8 per cent since 2000. Discussant **Marc-André Gosselin** (Bank of Canada) pointed out that the findings of the paper were broadly consistent with research on the euro area conducted at the Bank of Canada. He added that the estimated trend seems to track the actual data too closely, and that, as a result, the authors perhaps overstate the slowdown in trend labour productivity and the pickup in trend hours worked since 2000.

Christophe Cahn and **Arthur Saint-Guilhem** (Banque de France) estimated potential growth for several economies: Canada, the euro area, France, Germany, Italy, Japan, the Netherlands, the United Kingdom, and the United States. A unique feature of this paper is that total factor productivity (TFP) is analyzed using econometric techniques and a specification that relates it to three factors: the capacity utilization rate, capital-embodied technological improvement[6] (which is partly captured by the effect of capital aging), and a trend in technology.[7] The model also allows for the existence of trend breaks in technological change. The results suggest that differences in the growth of labour input, rather than capital input, have played a crucial role in explaining the lagging growth in Europe and Japan compared with that of the United States and Canada. Second, some economies, namely Canada and the United States, experienced a sharp acceleration in potential output growth in the mid-1990s. For the United States, this was mainly a result of the acceleration in the growth of TFP (+0.5 percentage points), whereas for Canada, it was attributable to the contribution of labour. **Don Coletti** (Bank of Canada), in his discussion, pointed out that the univariate time-series techniques used by the authors to try to uncover trend breaks in TFP growth have very low power, particularly near the end of sample, where they are most relevant for policy-makers.

3. These figures are taken from the OECD *Economic Outlook*, various issues.

4. Labour productivity is defined as output per hour worked.

5. Average hours worked per person have declined gradually over the past three decades. In very recent years, however, the trend level of hours worked per person has remained, on average, broadly unchanged or has even gradually increased.

6. Capital-embodied technological improvement refers to the adoption of advances in technology through acquisition of capital stock whose design and construction reflects those advances.

7. In general, growth in TFP represents output growth not accounted for by growth in capital and labour.

Werner Roeger (European Union Commission) assessed recent potential output growth and productivity trends in the European Union and the United States, using a production-function approach. Consistent with the results presented in the previous papers, the author finds that potential growth is on a downward trend in the European Union. In particular, for the euro area, potential growth declined from 2.5 per cent in the mid-1980s to 1.9 per cent over the 2001–2005 period. This compares to a fairly stable potential growth trend for the United States of about 3.0 per cent over the same periods. The author also finds that potential output in the European Union is characterized by two divergent trends; namely, declining growth of TFP that is not fully compensated by a rising contribution of labour. His preferred explanation for the declining trend in productivity growth centres on the European Union's weak performance in terms of the production of information and communications technology (ICT). **Jean-Paul Fitoussi** (Observatoire Français des Conjonctures Economiques), in his discussion, pointed out that these estimates of potential output level and growth depend only on supply-side variables, which are considered exogenous. He argued that the determinants of potential output are partly determined by demand-side variables over the medium and long term.

Michel Juillard (CEPREMAP[8]), **Ondra Kamenik** (Czech National Bank), **Michael Kumhof** (International Monetary Fund), and **Douglas Laxton** (International Monetary Fund) (JKKL) develop and estimate a DSGE model of the U.S. economy that allows for both transitory and highly persistent shocks to the growth rate of TFP. Allowing for the highly persistent shocks helps the model to generate a positive correlation between hours worked and output at business cycle frequencies. JKKL use their model to compute an extended real-time measure of potential output using a Hodrick-Prescott (HP) filter. As the authors note, it is well known that univariate filters such as the HP filter give very imprecise estimates of the output gap at the end of the sample.[9] JKKL exploit the good forecasting performance of their model to construct a two-sided measure of the output gap. The extended measure is constructed by treating the model's forecasts as additional data that extend the sample period and then using the sample period to estimate potential output. To evaluate this extended measure of potential, JKKL look at the magnitude of the revisions that would be required as new data become available and find that the extended measure requires less revision, on average, than the standard measure. On this basis, they conclude that their extended HP filter measure is more reliable. The discussant, **Patrick Fève** (Banque de France and Université de Toulouse), pointed out that it is not surprising that the DSGE model performs well compared with other economic and statistical models, since it includes numerous exogenous stochastic processes and several non-parsimonious structural parameters.

Magnus Jonsson, **Stefan Laséen**, and **Karl Walentin** (Sveriges Riksbank) studied the usefulness of four possible indicators of inflation: (i) the trend-adjusted output gap (i.e., the traditional output gap); (ii) the flexible-price output gap; (iii) the flexible-price real interest rate gap; and (iv) real marginal cost of production within the context of the Swedish Riksbank's new DSGE model (Adolfson et al. 2005).[10] The authors find the only "reliable indicator" of inflation over history to be the flexible-price real interest rate gap. Although it is well known that the real interest rate gap is a good indicator of inflation in simple New Keynesian models (see, e.g., Neiss and Nelson 2003), the paper contributes to the literature by extending this result to a much larger model with a variety of shocks and frictions. The discussant, **Rhys Mendes** (Bank of Canada), pointed out that, in models of this class, aggregate demand depends not just on the current real interest rate, but also on all future rates. Hence, the fact that the current real interest rate gap has good indicator properties suggests that monetary policy, over history, was not fully exploiting the role of expectations. But policy-makers increasingly view the policy problem as one of managing expectations so as to influence the entire yield curve. Thus, new developments in the communication and practice of monetary policy may, over time, weaken the indicator properties of the real interest rate gap.

8. CEPREMAP is the Centre Pour la Recherche Economique et ses Applications in Paris, France.

9. The HP filter takes an average of past and future data. At the end of the sample, it only uses past information.

10. The flexible-price output gap is defined as the difference between actual output and the level of output that would prevail if all prices and wages were perfectly flexible. Similarly, the flexible-price real interest rate gap is defined as the difference between the real interest rate and the level of interest rates that would prevail if all prices and wages were perfectly flexible.

Theme 2: Productivity and Growth

The second group of papers used growth accounting to review historical developments in growth in the gross domestic product (GDP) in the United States and the United Kingdom. Growth accounting breaks down economic growth into components associated with changes in factor inputs and TFP.

Dale Jorgenson (Harvard University), **Mun Ho** (Resources for the Future Inc.), and **Kevin Stiroh** (Federal Reserve Bank of New York) analyzed the sources of U.S. productivity growth through 2004 and compared the first surge in productivity growth after 1995 with the second surge after 2000. The paper finds important differences between the two episodes. The acceleration in productivity growth in the first surge was driven by the production and use of information technology (IT) equipment and software. The contribution of both IT total factor productivity and IT capital deepening accounted for most of the acceleration in productivity growth. In contrast, these forces played a much smaller role in explaining the second productivity surge, which was more heavily influenced by both non-IT capital deepening and non-IT-related growth in TFP. The authors project growth for the next decade in U.S. private sector productivity of 2.6 per cent per year, close to the 1995–2000 average, but a substantial decline from the torrid pace of 2000–2004. The authors emphasize the substantial range of uncertainty by presenting an optimistic projection of productivity of 3.2 per cent per year and a pessimistic projection of only 1.4 per cent. The discussant, **Nicholas Oulton** (London School of Economics), pointed out that imposing a constant capital-output ratio in the medium-to-long run helps to reduce the uncertainty around the base-case projection.

Nicholas Oulton and **Sylaja Srinivasan** (Bank of England) used a new industry-level data set to quantify the roles of structural change and information and communication technology (ICT) in explaining productivity growth in the United Kingdom over the 1970–2000 period. The authors find that, despite being only a small fraction of the total capital stock, ICT-related capital deepening accounted for 47 per cent of productivity growth in the market sector over the 1995–2000 period, up from 15 per cent over the 1990–95 period and from 22.5 percent over the 1970–2000 period. Supplementary econometric evidence also supports an important role for ICT-related capital deepening. On the other hand, the authors find that TFP growth slowed between 1995 and 2000. The authors also show econometric evidence that a boom in "complementary investment," i.e., expenditure on reorganization that accompanies ICT investment but is not officially measured as investment, could have led to a decline in the conventional measure of TFP growth. Discussant **Kevin Stiroh** remarked that acceleration in TFP and ICT capital deepening are concentrated in fewer industries in the United Kingdom than in the United States, and that this difference across the two countries is not well understood.

Theme 3: Institutions, Policies, and Growth

While IT is credited with the acceleration in productivity that took place in the United States between 1995 and 2002, many other industrialized countries have not experienced a pickup in productivity growth. By its nature, the adoption of new technology should be causing productivity growth to rise in all the industrialized countries because IT is not specific to a particular location and can easily be applied to other economies. Some researchers have argued that continental Europe's relatively weak productivity performance could be a result of its tax and regulatory framework, which is thought to stifle competitive forces and hamper IT diffusion. Although an abundant literature exists on the negative effects on economic growth and economic welfare implied by structural market rigidities, empirical evidence that quantifies these effects remains relatively imprecise. Moreover, these effects appear to depend on the way reforms are introduced (sequentially vs. concurrently) and the market they affect (labour vs. product).

In previous work, Gust and Marquez (2002) have investigated the reasons why IT may be more readily adapted in some economies than in others. The basic intuition behind their results is that inflexibility in labour and product markets prevents firms from making the adjustments required to benefit from the new IT. **Christopher Kent**, **John Simon**, and **Kathryn Smith** (Reserve Bank of Australia) extend that work using 30 years of cross-country data by asking whether market flexibility influences TFP growth independently of whether a country has invested heavily in ICT. The authors find tentative empirical support for the hypothesis that lower levels of regulation in product and labour markets are associated with higher TFP growth in subsequent years. The authors also find evidence that labour and product market deregulations have more effect in combination than separately. The discussant, **Remy Lecat** (Banque de France), highlighted some of the difficulties associated with using

the common indicators of the labour and product market regulations in this sort of analysis.

Andrea Bassanini (Organisation for Economic Co-operation and Development, OECD) and **Romain Duval** (OECD) presented an extensive study of the impact of structural policies and institutions on aggregate unemployment and employment rates across countries belonging to the OECD. Their analysis was based on cross-country / time-series econometric estimates of reduced-form models of unemployment and labour force participation rates. Some main findings are that the effects of macroeconomic shocks on unemployment appear to be amplified by high unemployment benefits and dampened by highly centralized or coordinated wage-bargaining systems. More tentatively, high rates of home ownership—which are often associated with low degrees of labour mobility across regions— increase the impact of shocks on unemployment, while public spending on active labour market policies (e.g., labour market training) reduces it. Policies and institutions affect employment through their impact on aggregate unemployment and also through their effects on labour market participation, particularly for those groups "at the margin" of the labour market. The paper also shows that a package of reforms sharing specific objectives will have a bigger effect than will a group of separate reforms. The discussant, **Gilbert Cette** (Banque de France), pointed out that, even if the results appear to bear out certain conclusions, they should be treated with caution because of simultaneity biases that could amplify some estimated results.

Danny Leung, **Césaire Meh**, and **Yasuo Terajima** (Bank of Canada) attempt to explain part of the difference in aggregate TFP between Canada and the United States by focusing on the relationship between the rate at which a firm adopts new technology and aggregate productivity in the presence of financial constraints. In their paper, they develop a dynamic general-equilibrium (DGE) model in which firms adopt technology endogenously and display dynamics (i.e., entry, growth, and exit) that are affected by financial market imperfections and taxation. The authors consider the implications of the differences between Canada and the United States in several determinants of technology adoption and firm size, such as financial market imperfections, the cost of adopting a technology, and the tax structures on aggregate TFP. They argue that a sizable part of the TFP gap between the two countries is a result of the difference in the economic environment that distorts a firm's technology-adoption behaviour. The discussant, **Jacques Mairesse**, National Institute of Statistics and Economic Studies (INSEE); Center for Research in Economics and Statistics (CREST); and National Bureau of Economic Research (NBER), pointed out that the relation between firm size and productivity level and growth is a difficult question that should be more explicitly treated in the paper.

Aaron Drew (Reserve Bank of New Zealand), **Max Dupuy** (New Zealand Treasury), **Richard Downing** (New Zealand Treasury), and **Özer Karagedikli** (Reserve Bank of New Zealand) reviewed the recent literature on New Zealand's labour productivity performance and offered empirical evidence that suggests there is scope for higher labour productivity growth in the future. The authors show that, although labour productivity growth in New Zealand improved to 1.1 per cent per year over the 1993–2005 period, it remained below the OECD average. They examine several possible reasons for the weakness in measured labour productivity growth, including measurement issues, the quality of policies and institutions, geography and scale, impediments to capital accumulation, and labour-absorption dynamics. The authors demonstrate that the entrance of less-qualified workers into the labour force held back productivity growth in the order of 0.5 percentage points per year, which is equivalent to the difference between New Zealand's recent growth rates in labour productivity and those of upper-income OECD countries. The paper also presents estimates of trend labour productivity from a multivariate Kalman filter. The uncertainty bands around the estimates of trend productivity encompass the growth rates of labour productivity of upper-income OECD countries. Given their empirical evidence and the findings in the existing literature, the authors feel there is room for labour productivity to improve as labour market deepening runs its course. Discussant **Gérard Belet** (Ministry of Finance, Government of France) pointed out that New Zealand's low rate of productivity growth seems to have the same cause as that of continental European countries: the increasing share of less-qualified people in employment, which is a result of immigration to New Zealand and of labour market policies designed to reduce unemployment among less-skilled people in Europe.

Rapporteur

Susanto Basu (Boston College and NBER) gave his perspective on recent academic research that examines productivity growth and offered some interesting sug-

gestions for future research. His presentation covered three key areas: i) interpreting the past: What happened in the U.S.? ii) predicting the future: What tools should we use? and iii) past and future: What (hasn't) happened in Europe?

In his presentation, Basu challenged the conventional view of information and communication technology (ICT) as the story to explain the acceleration in U.S. productivity growth since 1995. He argues that much of the acceleration is an increase in TFP outside of the production of ICT (Basu, Fernald, and Shapiro 2001). Although ICT should—and does—show up in labour productivity growth in ICT-using industries, there is no reason why that should be the case for TFP in ICT-using industries. Basu concludes that, if the rise in TFP in ICT-using industries was caused by ICT, then it occurred through a channel that is not well understood.[11] He then suggested that studying the economic history associated with the advent of other great inventions like the telegraph or railroads may be able to help us improve our understanding of the processes at work.

Basu reviewed the relative advantages and disadvantages of the main tools available to economists for predicting the future: i) growth accounting combined with extrapolative techniques; ii) single- or multi-variable statistical models and predictions based on estimated stochastic processes; and iii) full economic models applied to the data. The key advantage associated with accounting-plus-extrapolation is that the exercise is very transparent. On the downside, we cannot assess the underlying uncertainty around these forecasts as well as can be done with the statistical approach. Both the growth accounting and statistical approaches, however, try to forecast the future from the recent behaviour of a few aggregate series. Since the historical productivity data for the U.S. contain only two trend breaks, this raises the issue of how the effects of something novel can be forecast. Alternatively, he argues that it might be advantageous to apply more well-developed economic models. Using an economic theory like the personal-income hypothesis, for example, can help us to infer what economic agents are thinking about the expected persistence of a change in TFP. Cochrane (1994) tells us that a large jump in consumption implies a large expected future increase in income, which in turn suggests to us that economic agents expect the increase in TFP that we observe to be quite persistent. Basu then described other examples of how economic theory could be used to inform our analysis, based on more recent and sophisticated papers by Ireland and Schuh (2006); Edge, Laubach, and Williams (2003); and Guerrieri, Henderson, and Kim (2005).

Finally, Basu discussed the European question and challenged the conventional pessimistic story that regulations and distortions in European economies have prevented the euro area from taking full advantage of new technological opportunities. He questioned how this story could be true in light of the rapid catch up of both Europe and Japan after World War II and the natural advantages to being "followers."

This summary will also be published in the February 2007 issue of Le Bulletin de la Banque de France. *Slight differences in the text represent the style of the two journals.*

11. The intuition here is that changes in factor prices don't shift production functions.

Literature Cited

Adolfson, M., S. Laséen, J. Lindé, and M. Villani. 2005. "Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through." Sveriges Riksbank Working Paper No. 179.

Basu, S., J. Fernald, and M. Shapiro. 2001. "Productivity Growth in the 1990s: Technology, Utilization, or Adjustment?" Carnegie-Rochester Conference Series on Public Policy 55: 117–65.

Cochrane, J. 1994. "Permanent and Transitory Components of GNP and Stock Prices." *Quarterly Journal of Economics* 104 (1): 241–65.

Edge, R., T. Laubach, and J. Williams. 2003. "Monetary Policy and the Effects of a Shift in the Growth Rate of Technology." Manuscript. Federal Reserve Bank of San Francisco.

Literature Cited (cont'd)

Guerrieri, L., D. Henderson, and J. Kim. 2005. "Investment-Specific and Multifactor Productivity in Multi-Sector Open Economies: Data and Analysis." International Finance Discussion Papers No. 828. Board of Governors of the Federal Reserve System (U.S.).

Gust, C. and J. Marquez. 2002. "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices." International Finance Discussion Papers No. 727. Board of Governors of the Federal Reserve System (U.S.).

Ireland, P. and S. Schuh. 2006. "Productivity and U.S. Macroeconomic Performance: Interpreting the Past and Predicting the Future with a Two-Sector Real Business Cycle Model." Boston College Working Papers in Economics No. 642. Boston College Department of Economics.

Neiss, K. and E. Nelson. 2003. "The Real-Interest-Rate Gap as An Inflation Indicator." *Macroeconomic Dynamics* 7 (2): 239–62.

Press Releases

Major press statements issued by the Bank of Canada and selected other official releases of related interest are published below.

Government of Canada
Bank of Canada
23 November 2006

Joint Statement of the Government of Canada and the Bank of Canada on the Renewal of the Inflation-Control Target

The primary objective of Canada's monetary policy is to enhance the well-being of Canadians by contributing to sustained economic growth, rising levels of employment and improved living standards. Experience has clearly shown that the best way monetary policy can achieve this goal is by giving Canadian households and businesses confidence in the value of their money.

It has been 15 years since Canada adopted an inflation targeting framework to guide its monetary policy. During this time, Consumer Price Index (CPI) inflation has been reduced to a low, stable and predictable level of close to 2 per cent, real output has expanded at an average rate of 3 per cent per year and the unemployment rate has fallen to 30-year lows. Although a generally supportive international environment, coupled with significant domestic economic reforms and a prudent fiscal policy track, has played an important role in these positive developments, a key contributor has been Canada's monetary policy under the inflation-targeting framework. The joint commitment of the Government of Canada and the Bank of Canada to the inflation targets has helped anchor inflation expectations. It has also provided a more stable and certain economic environment in which Canadians can make their investment and spending decisions.

Based on this positive experience, the Government of Canada and the Bank of Canada agree to renew the inflation target on the following basis:

- The target will continue to be defined in terms of the 12-month rate of change in the total CPI.
- The inflation target will continue to be the 2 per cent mid-point of the 1 to 3 per cent inflation-control range.
- The agreement will run for another five-year period, ending 31 December 2011.

The Bank will continue its ongoing research into potential improvements in the monetary policy framework. Before the end of 2011, the Government and the Bank will review the experience over the period and the results of the research, and determine the appropriate target for the years ahead.

The commitment by the Government and the Bank to this inflation-control target will ensure that Canadians continue to derive the economic and social benefits from low, stable and predictable inflation and will underpin confidence in Canada's economic prospects in the coming years.

For further information:

David Gamble
Media Relations
Department of Finance
613 996-8080
www.fin.gc.ca

Annie Portelance
Media Relations
Bank of Canada
613 782-8782
www.bankofcanada.ca

Bank of Canada
27 November 2006

Bank of Canada Releases Background Information on Renewal of the Inflation-Control Target

The Bank of Canada today released the document *Renewal of the Inflation-Control Target: Background Information*, which describes Canada's experience with inflation targeting, reports on some key issues bearing on the framework for conducting monetary policy, and identifies issues warranting further research.

This release follows the 23 November announcement by the Government of Canada and the Bank of Canada that the inflation-control target has been renewed for a period of five years to the end of 2011. Under the agreement, the Bank will continue to conduct monetary policy aimed at keeping inflation, as measured by the consumer price index (CPI), at 2 per cent, with a control range of 1 to 3 per cent around this target.

Key elements discussed in the *Background Information* document include the following:

- **Canada's experience with inflation targeting:** Since Canada adopted inflation targets in 1991, total CPI inflation has averaged very close to 2 per cent, and the variability of inflation has been significantly lower than was the case in the 15 years before inflation targeting. Success in reducing inflation, coupled with an explicit commitment to keep inflation low, stable, and predictable through time, has helped to anchor inflation expectations to the 2 per cent target. A low-inflation environment has contributed to sound economic performance and the well-being of Canadians in a number of important ways. Consumers and businesses have been able to manage their finances with greater certainty about the future purchasing power of their savings and income. Nominal interest rates, both short and long term, have been much lower and more stable. Output growth in the economy has been generally higher and significantly more stable, while unemployment has been lower and less variable. The more stable price environment provided by inflation targeting has also helped the economy adjust to economic shocks, such as the global high-tech bubble, 9/11, SARS, and the rapid rise in oil prices, allowing businesses and households to allocate resources more efficiently.
- **Total inflation and core inflation:** The inflation target will continue to be set in terms of the 12-month increase in the total consumer price index. This reflects its role as the most commonly used indicator of inflation in the Canadian economy and the most relevant estimate of the cost of living for most Canadians. Total CPI inflation, however, is subject to considerable variability and so is not always the best indicator of the underlying trend in inflation and, therefore, of where inflation is likely to be in the future. For this reason, core inflation–which removes volatile price components–provides a useful guide for the conduct of monetary policy. In the context of the new inflation agreement, the Bank intends to continue using CPIX as its preferred measure of core inflation. CPIX strips out eight of the most volatile components of total CPI, as well as the effect of changes in indirect taxes on the remaining CPI components. As in the past, the Bank will continue to look at a range of measures in order to assess the underlying trend of inflation.
- **The target time horizon:** Based on recent research, the Bank has concluded that the present policy of bringing inflation back to the 2 per cent target within six to eight quarters (18 to 24 months) is still appropriate generally, although specific occasions may arise in which a somewhat shorter or longer time horizon might be appropriate. For example, the persistence of lower observed inflation might suggest, in some instances, a shorter time horizon. Similarly, the longer-lasting nature of some shocks, such as large asset-price movements could, in some instances, suggest

a longer horizon. A full discussion of the shocks to the Canadian economy, and of the Bank's policy response to them, will be provided in the Bank's *Monetary Policy Reports*.

- **Asset prices and the inflation target:** It remains the Bank's view that no explicit recognition should be given to asset prices in the inflation-target index, beyond the recognition already accorded the price of housing services in the CPI. The Bank will focus on the inflation and output consequences of any economic disturbance, including asset-price shocks, and will continue to respond in a manner consistent with meeting its long-run inflation objective. However, as noted above, some flexibility might be required with regard to the time horizon over which the target is achieved. This might involve sacrificing something in terms of inflation performance over the usual horizon, but could lead to greater financial, economic, and inflation stability over a somewhat longer horizon. If the Bank judged that the time horizon should be adjusted relative to the usual six to eight quarters, it would communicate the reasons for the change and how it planned to respond.

- **Issues warranting further research:** While Canada's 15 years of experience with inflation targeting have been very positive, there remains the question of whether the specific regime established in the 1990s will deliver the greatest contribution to economic performance and to the well-being of Canadians in the decades ahead. With this in mind, the Bank plans to lead a concerted research program to learn from our experience and the experience of others, and to examine whether and how the monetary policy framework in Canada might be improved. Building on recent research on inflation-targeting frameworks, the research program led by the Bank will focus on the potential costs and benefits of targeting a lower rate of inflation or of pursuing a price-level target instead of an inflation target. The research program will also consider any necessary reassessment of issues covered in the past and assessment of any new issues that may arise. Other interested researchers are invited to join the effort. The goal is to complete this research well in advance of the next renewal date in 2011 so as to ensure sufficient time for open discussion of the results and their implications.

Renewal of the Inflation-Control Target: Background Information

The Government and the Bank of Canada have renewed Canada's inflation-control target for a further five-year period, ending 31 December 2011. Under this agreement, the Bank will continue to conduct monetary policy aimed at keeping inflation, as measured by the consumer price index (CPI), at 2 per cent, with a control range of 1 to 3 per cent around this target.

Background

Since Canada adopted an inflation-targeting regime in 1991, the record shows that inflation has been low and stable and, as a result, Canadians have benefited in a number of important ways. An improved inflation environment has allowed consumers and businesses to manage their finances with greater certainty about the future purchasing power of their savings and income. Low and stable inflation has also meant that interest rates, both in nominal and real terms, have been lower. More broadly, low, stable, and predictable inflation has helped encourage more stable economic growth in Canada and lower and less-variable unemployment. Section 1 of this background document discusses the main benefits of Canada's inflation-control strategy.

In preparation for the renewal of the agreement, several issues were investigated to further strengthen and clarify the framework within which the Bank will be conducting monetary policy over the next five years. The conclusions reached by the Bank on three key issues—the role of core inflation, the appropriate time horizon for returning inflation to target following economic shocks, and the implications of asset-price movements—are discussed in Section 2.

The inflation-targeting regime in Canada has led to greatly improved inflation performance and greater economic stability. There always remains the question, however, of whether the specific regime established in the 1990s will deliver the greatest contribution that monetary policy can make to economic performance and to the well-being of Canadians in the decades ahead. With this in mind, the Bank plans to lead a concerted research program over the next three years, and to publish the results for public discussion well in advance of the next renewal date in 2011. The goal of this research will be to learn from our experience and that of others, and to examine whether and how the monetary policy framework in Canada might be improved. The Bank invites others to join this research program, since we know that a broad and open research effort will produce more robust findings. Section 3 discusses the issues and planned research program in greater detail.

1. Canada's Experience With Inflation Targeting

Canada first announced inflation targets in February 1991. The initial objective was to reduce inflation from an underlying rate of roughly 4 to 5 per cent at the start of 1991 to 2 per cent by the end of 1995. Focus then shifted towards maintaining a low, stable, and predictable 2 per cent rate of inflation. The inflation targets have been extended on four occasions since 1991 (in 1995, 1998, 2001, and now 2006). Experience during this time has shown that Canada's economic performance improved with the introduction of the targets and with the success achieved in meeting them. In conjunction with other factors, most notably a sound fiscal policy, the inflation targets have clearly made an extremely important contribution. All the major benefits that an inflation-targeting framework was supposed to deliver have been realized and, in some cases, exceeded. There were also costs associated with the adjustment

to lower inflation, given the very difficult circumstances that existed in 1990–91 in Canada. It took some time for the credibility of the new regime to be established and for inflation expectations to converge on the target, although less time than many analysts had expected. Against this one-time adjustment cost, the benefits of low, stable, and predictable inflation have been ongoing.

1.1 Inflation performance

The first benefit that was expected from moving to an inflation-targeting framework was a lower and more stable inflation rate. Table 1 contains summary statistics for total CPI inflation over various periods. This is the inflation series regularly reported by Statistics Canada for all the price components in the consumer basket and is the inflation rate to which the inflation target applies.

Table 1

Inflation Performance over Different Time Periods*

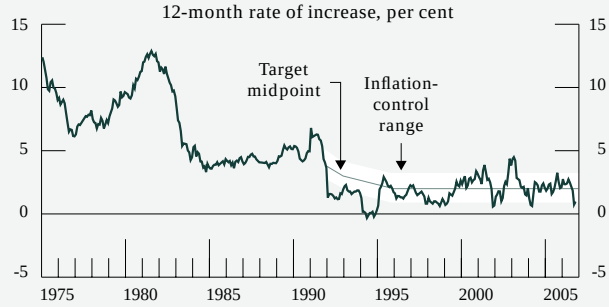
	1975M1 to 1991M1	1991M2 to 2006M10	1995M12 to 2006M10	1995M12 to 2001M4	2001M5 to 2006M10
Average (%)	7.1	2.1	2.0	1.8	2.3
Standard deviation	2.9	1.3	0.9	0.7	0.9
Percentage of time within the control range	n.a.	71	80	83	77

* Inflation is defined as the 12-month rate of increase in the total CPI.

A comparison of the period preceding the adoption of inflation targets with the period that succeeded it, highlights several differences. First, inflation since 1991 has been significantly lower, on average, than it was from 1975 to 1991. Second, the variability of inflation, as measured by the standard deviation of total CPI inflation, has also been significantly lower.

Total CPI inflation has averaged very close to 2 per cent throughout the period of inflation targeting, particularly since 1995. Over this latter period, inflation has remained within the control range of 1 to 3 per cent 80 per cent of the time. Moreover, in 2006, the level of the CPI has been close to what would have been anticipated had inflation of exactly 2 per cent been achieved every year since 1995.[1]

Chart 1
Consumer Price Index
12-month rate of increase, per cent



Note: Total CPI inflation is affected temporarily by changes in indirect taxes. The February 1994 tobacco tax cut reduced CPI inflation by 1.3 per cent in 1994, and the July one-percentage-point cut in the Goods and Services Tax (net of a small contribution from two excise tax increases) reduced CPI inflation by 0.5 percentage points.

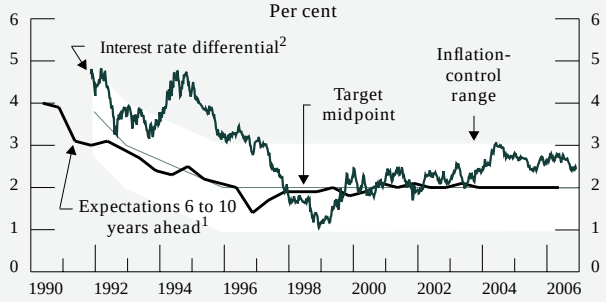
For the five-year period covering the latest inflation-targeting agreement, average inflation and the variability of inflation have risen slightly relative to the 1995 to 2001 period. This largely reflects the significant price shocks hitting the Canadian economy during this period, particularly the marked rise in the world price of oil. Overall, Canadian inflation over the period of the last agreement has been remarkably well behaved (Chart 1), particularly when compared with the experience in the 1970s and early 1980s when there were similar oil-price shocks.

1.2 Inflation expectations

Success in reducing inflation, coupled with an explicit commitment to keep inflation low and stable through time, has helped to anchor inflation expectations. This has allowed businesses and households to take a longer view with respect to their planning, which has led to a better allocation of economic and financial resources. Well-anchored inflation expectations have also helped to reduce the pass-through of exchange rate and energy-price shocks to wages and prices, as well as dampening

1. If the inflation rate had been consistently and exactly 2 per cent since the target has been 2 per cent, the level of the CPI in the first 10 months of 2006 would have averaged 128.8. The actual level of the CPI averaged 129.9 from January to October 2006, a difference of less than 1 per cent. For October 2006—the most recent month—the actual price level (129.7) is the same as the price level that would have prevailed had inflation been exactly 2 per cent in every month since December 1994.

Chart 2
Measures of Inflation Expectations
Per cent



1. Forecast 6 to 10 years ahead taken from the semi-annual survey by Consensus Economics Inc.
2. Interest rate differential on 30-year nominal and Real Return bonds (weekly)

the sensitivity of inflation to excess demand and excess supply. All of this has made the conduct of monetary policy more effective and efficient. A self-reinforcing system seems to have developed, in which a better monetary policy framework has led to better inflation outcomes. This, in turn, has led to increased policy credibility and a more stable macroeconomic environment.

There are two popular methods of estimating inflation expectations. The first involves surveying professional forecasters and other interested observers. The second involves deriving inflation expectations from the interest rate differentials reported on nominal and Real Return bonds (Reid, Dion, and Christensen 2004). Chart 2 contains representative results based on these two approaches. Both measures suggest that inflation expectations fell significantly after the introduction of inflation targets and stabilized around the 2 per cent target. Projections of inflation made by professional forecasters converged to the target very quickly, while those implied by the real-nominal interest rate differential did not converge until bondholders were convinced that fiscal policy in Canada was on a sustainable track. Note also that estimates taken from the interest rate differential are more variable, largely because of the nature of the market for Real Return Bonds. For example, while the widening of the interest rate differential in the past two years suggests some increase in inflation expectations, this widening appears to be partly related to a strong demand for Real Return Bonds from institutional investors at a time when the supply has remained relatively low.

1.3 Output growth, employment, and financial markets

An important reason for having a monetary policy directed towards achieving low, stable, and predictable inflation is the contribution that it makes to overall economic and financial stability. Table 2 repeats some of the information presented in Table 1 and extends the analysis to interest rates, output growth, and employment. Many factors have played a role in the improved performance of these other indicators, but Canada's inflation-targeting regime has been an important contributing factor (Jenkins and O'Reilly 2001; Longworth 2002). As inflation expectations fell and became more firmly anchored on the inflation target, nominal interest

Table 2

Canada's Economic Performance

	Average (%)			
	1975M1 to 1991M1	1991M2 to 2006M10	1995M12 to 2006M10	2001M5 to 2006M10
CPI: 12-month increase	7.1	2.1	2.0	2.3
Real GDP growth[1]	2.9	3.1	3.4	2.6
Unemployment rate	8.9[2]	8.6	7.7	7.2
3-month interest rate	10.9	4.7	3.9	3.0
10-year interest rate	10.8	6.2	5.4	4.7
	Standard deviation			
	1975M1 to 1991M1	1991M2 to 2006M10	1995M12 to 2006M10	2001M5 to 2006M10
CPI: 12-month increase	2.9	1.3	0.9	0.9
Real GDP growth[1]	3.8	2.0	1.9	1.6
Unemployment rate	1.7[2]	1.6	1.0	0.5
3-month interest rate	3.0	1.8	1.2	0.7
10-year interest rate	2.0	1.6	0.9	0.5

1. Annualized quarter-over-quarter growth rate for the periods: 1975Q1 to 1991Q1; 1991Q2 to 2006Q2; 1995Q4 to 2006Q2; 2001Q2 to 2006Q2
2. 1976M1 to 1991M1. The sample starts in 1976M1, owing to the introduction of a new labour force survey at that time.

rates, both short and long term, became much lower and more stable. Firmly anchored inflation expectations have also encouraged the use of longer-term contracts in labour and financial markets, as well as a decline in the use of cost-of-living index clauses. On the real side of the economy, output growth has been generally higher and significantly more stable over the 1991 to 2006 period, while the unemployment rate has fallen to a 30-year low.

1.4 Adjustment to macroeconomic shocks

During the past five years, the Canadian economy has been hit by a number of external and domestic shocks. These have included the collapse of the global high-tech bubble, 9/11, corporate scandals, SARS, BSE, and the rapid rise of oil prices. We have also had to face the emergence of China, India, and other emerging-market countries as major economic forces. And since 2003, we have experienced a sharp appreciation of the Canadian dollar, which has primarily reflected strong world demand and high prices for the energy and other commodities that Canada produces. Although adjustment to these shocks has been difficult, the Canadian economy has demonstrated more flexibility and adaptability than was the case in earlier episodes involving shocks of a similar nature. Structural changes undertaken over the past number of years account for a good part of this increased flexibility. The more stable price environment provided by inflation targeting has also been an important contributing factor, allowing Canadian businesses and households to read price signals more clearly, respond to relative price shocks more promptly, and generally allocate resources more efficiently.

2. The Inflation-Control Framework: A Review of Some Key Issues

Prior to this latest renewal of the inflation target, Bank staff reviewed the literature and undertook new research on a number of issues. Several of these issues were also central to the Bank's work leading up to the renewal in 2001. From the staff's most recent review, the Bank has drawn conclusions related to how three issues will be approached in terms of the basic framework for conducting monetary policy over the five years of the current agreement. The three issues—core inflation as a useful guide to policy, the appropriate time horizon for returning inflation to target, and the implications of asset-price movements—are discussed in this section.

On issues related to the level and form of the inflation target, research has been less conclusive. Further research on these issues will be required, as discussed in Section 3.

2.1 Core inflation as an indicator of the underlying trend in inflation

The inflation target continues to be set in terms of the 12-month increase in the total consumer price index (CPI). Use of the CPI as the basis for the target reflects its role as the most commonly used indicator of inflation in the Canadian economy and the most relevant estimate of the cost of living for most Canadians.

Total CPI inflation, however, is subject to considerable variability and so is not always the best indicator of the underlying trend in inflation and, therefore, of where CPI inflation is likely to be in the period ahead. Because of the time lags associated with monetary policy actions, it is important for the Bank to focus on where inflation is likely to be 1 1/2 to 2 years into the future. Measures of core inflation, along with indicators of capacity pressures, have been shown to be useful indicators of underlying inflation and, hence, of where total CPI inflation could be in the future. For this reason, core inflation provides a useful guide for the conduct of monetary policy.

It should be noted, however, that core inflation provides a useful guide to the extent that total CPI inflation is projected to converge to core inflation. If this were not expected to be the case, owing to anticipated persistent changes in the CPI components that are excluded from the core measure, total CPI inflation would take precedence. In other words, it would be necessary, in such a situation, to pursue a lower, or higher, rate of increase in core inflation in order to achieve the target for the total CPI.

The measure of core inflation used by the Bank (CPIX) strips out many of the most volatile components of total CPI. The eight components dropped from the all-items index are: fruit and vegetables, gasoline, fuel oil, natural gas, intercity transportation, tobacco, and mortgage-interest costs. The effects of changes in indirect taxes on the remaining CPI components are also excluded (Macklem 2001). As can be see from Table 3, the

variability of CPIX is substantially less than that of total CPI. As well, the mean values for the rates of increase of the CPI and CPIX are similar in all subperiods of our inflation-targeting experience in Canada.

As inflation expectations have become more firmly anchored, the usefulness of core inflation as a predictor of total CPI inflation has declined somewhat. Updated empirical studies, however, suggest that CPIX still retains an informational advantage and allows the Bank to assess the underlying trend in inflation with greater accuracy than the use of total CPI alone would permit (Armour 2006; Armour and Laflèche 2006).

Table 3

Total vs Core CPI Inflation

	1991M2 to 1995M11	1995M12 to 2001M4	2001M5 to 2006M10
12-month rate of increase (%)			
Total CPI	2.2	1.8	2.3
Core CPI (CPIX)	2.1	1.5	2.0
Standard deviation			
Total CPI	1.8	0.7	0.9
Core CPI (CPIX)	0.4	0.4	0.5

The Bank intends to continue using CPIX as its preferred measure of core inflation. But there are other inflation measures, such as CPIW, that also contain useful information.[2] In this regard, it is important to note that, as in the past, the Bank will continue to look at a range of measures in order to assess the underlying trend of inflation. Considerable judgment must always be applied, and no one measure is relied on exclusively.

2.2 The target horizon

The Background Information document released at the time of the 2001 inflation target renewal observed that "Shocks to demand and supply may push inflation in ways that cannot be offset in the short run because there are lags in the effect of monetary policy. Monetary policy will therefore be directed to moving inflation back to the target midpoint over a six-to-eight-quarter horizon" (Bank of Canada 2001a). More recent research, conducted by Bank economists in preparation for this latest renewal, suggests that the horizon of six to eight quarters remains a reasonable estimate of the average time period within which the Bank should aim to bring inflation back to the 2 per cent target following a shock.

Over the past 15 years, there appears to have been a marked reduction in the persistence of inflation. The autocorrelation coefficient on quarterly inflation, which is often used to measure the persistence of a variable, has fallen from approximately 0.8 in the 1980s, to essentially zero in the past 10 years. In earlier periods, inflation displayed considerable inertia and was difficult to unwind once it had risen. It now shows a tendency to revert more quickly to the 2 per cent target following a disturbance. This development is not unique to Canada and has been observed in several other industrial countries that have successfully lowered inflation. While it is impossible to credit the reduced persistence to a single factor, the anchoring effect that inflation targeting has had on inflation expectations and, hence, on realized inflation rates, has no doubt exerted an important influence (Levin, Natalucci, and Piger 2004). The significance of this from the perspective of monetary policy implementation is that it may be possible, in some instances, to respond to both anticipated and actual shocks over a somewhat shorter horizon.

At the same time, studies at the Bank of Canada using detailed macroeconomic models to simulate the effects of a wide variety of disturbances have shown that some shocks have more long-lived effects than others and might, therefore, require a longer time horizon to bring inflation back to target (Coletti, Selody, and Wilkins 2006). Some of the most frequently cited examples in this regard are large asset-price shocks, such as a sudden decline in equity or housing prices.

Overall, the conclusion that the Bank has drawn from the research is that the present policy of bringing inflation back to target within a horizon of six to eight quarters is still appropriate generally, although specific occasions may arise in which a somewhat shorter or longer time horizon might be considered. A full discussion of the shocks to the Canadian economy and of the Bank's policy response to them, will be provided in the Bank's *Monetary Policy Reports*.

2. CPIW adjusts the weights of the various CPI components in a fashion inversely proportional to their variability. The Bank regularly reports on CPIW in its *Monetary Policy Report*.

2.3 Asset prices

Asset prices have been at the centre of some of the most active monetary policy debates in recent years. The experience of Japan in the late 1980s, with the sudden collapse of its asset-price bubble, has served as a useful reminder that stable consumer prices are no guarantee of financial and economic stability. A similar message was repeated with the high-tech bubble in North America 10 years later. These episodes have raised important questions about how central banks should assess and respond to asset-price movements.[3]

In the late 1990s and early 2000s, the Bank's view, in line with the consensus view of the central banking community, was that central banks should focus on asset prices only to the extent that they provided additional information on future output and inflation, and should respond accordingly in the context of the existing monetary policy framework. An alternative view held that the targeted price index should be changed to give more explicit recognition to the stabilization of asset prices in policy formulation. Three main arguments have been put forward to counter this view. First, it was noted that asset-price bubbles are very difficult to identify, let alone correct. Second, traditional monetary policy instruments are not well suited to correcting asset-price misalignments. Third, the best contribution that central banks can make to economic stability in the context of an asset-price bubble is to minimize the damage associated with the bursting of a bubble by reacting with timely remedial action after it has occurred (Laidler 2004).

Since the early 2000s, there has been a slight shift in the consensus view. There remains general agreement, to which the Bank of Canada continues to subscribe, that no explicit recognition should be given to asset prices in the target index, beyond the recognition already accorded the price of housing services in the CPI. In essence, therefore, the central bank's mission should remain unchanged. The central bank should focus on the inflation and output consequences of any economic disturbance, including asset-price shocks, and it should continue to respond in a manner consistent with meeting its long-run inflation objective. Some flexibility might be required, however, with regard to the time horizon over which this is realized. This, in turn, might involve sacrificing something in terms of inflation performance over the usual horizon but could lead to greater financial, economic, and inflation stability over a somewhat longer horizon.

While it might be appropriate for monetary policy to respond to asset-price developments in exceptional circumstances, and, in so doing, to extend the horizon for returning inflation to its target level, the Bank has concluded that, in most situations, the existing time frame of six to eight quarters would still be relevant.[4] In circumstances where it was judged that the horizon should be adjusted, the Bank would indicate, through its communications, the reasons for the change and how it planned to respond.

3. Issues Warranting Further Research

After 15 years of experience with inflation targeting in Canada, it is clear that focusing monetary policy on keeping inflation low, stable, and predictable has helped the economy function more efficiently and has improved the economic well-being of Canadians. In recent years, researchers have begun to explore whether it might be possible to further improve inflation-control frameworks to achieve additional benefits in terms of better economic performance. Much of this research has focused on the potential net benefits to an economy from targeting a lower rate of inflation or from targeting a price-level path instead of inflation. As noted earlier, this research is at an early stage and a number of outstanding issues remain.

The Bank, therefore, plans to lead a concerted research effort over the next three years. Other interested researchers are invited to join the effort. The research program will focus on two broad sets of questions:

- What are the costs and benefits of an inflation target lower than 2 per cent? Would an inflation target lower than 2 per cent generate significant net benefits for the economy and for Canadian households?

3. The discussion in this section focuses on movements in equity and housing prices, as opposed to exchange rates. The Bank's views on exchange rate movements are described in some detail in the January 2005 *Monetary Policy Report Update*, as well as in numerous speeches.

4. See Selody and Wilkins (2004) and Tetlow (2006). The serious challenge of identifying when an asset-price movement might require an exceptional policy response remains an important complication for the practical application of this strategy.

- What are the costs and benefits of replacing the current inflation target with a longer-term, price-level target? Would a price-level target produce significant net benefits for the economy and for Canadian households?

An important aspect of this research will be to examine the extent to which the choice of the monetary policy framework in an open economy, such as Canada, should be influenced by the choice of the monetary policy framework of a major trading partner.

3.1 Targeting lower inflation

Targeting a low, stable, and predictable inflation rate of 2 per cent per annum removes much of the uncertainty and economic costs associated with high and volatile inflation, such as Canadians experienced during the 1970s and 1980s. It does not, however, eliminate all of the costs associated with inflation. A 2 per cent rate of inflation causes the price level to double approximately every 35 years. Although the erosion in purchasing power is difficult to notice year by year, it can still pose a serious problem on a cumulative basis. This erosion is particularly acute for those pensioners on a fixed income.[5] It can also distort price signals, because of potential confusion between movements in relative prices and a change in the aggregate price level, and it can impose "menu costs" by creating the need to regularly adjust prices. The key questions are whether the benefits of reducing the target rate of inflation below 2 per cent are significant, and whether the prospective benefits would outweigh the possible transition costs associated with achieving a lower ongoing inflation rate (Ragan 1998).

The reasons traditionally given for not targeting an inflation rate closer to zero have centred primarily on three issues: (i) the measurement error embedded in existing price indexes; (ii) the labour market consequences of the presence of downward nominal wage rigidities; and (iii) the problems posed by the constraint that nominal interest rates cannot go below zero.

The importance of the first two issues from a monetary policy perspective appears to have diminished over time. Estimates of the upward bias in CPI inflation in Canada are modest.[6] The latest Bank of Canada research on this issue concludes that the measurement error in Canada's CPI is, at most, 0.75 per cent, and more likely 0.5 to 0.6 per cent (Rossiter 2005).[7] There is also little evidence that labour market adjustment has been inhibited by low inflation. While there is evidence of a limited amount of downward nominal wage rigidity, this does not appear to have increased the average unemployment rate. Indeed, unemployment rates in Canada have fallen to their lowest levels in 30 years.[8] The implication is that these two issues, by themselves, would not appear to provide a compelling argument against a lower inflation target, although they could have implications for how much lower. This issue will require further examination.

The third issue—the zero lower bound on nominal interest rates—has received considerable attention in recent years, and understanding its implications will be critical to assessing the potential net benefits of a lower inflation target, or of a target path for the price level. This attention is partly explained by the recent experience of Japan, which faced persistent price deflation and weak output growth for most of the 1990s and early 2000s. One of the policy dilemmas that Japan had to deal with during this period was the difficulty it faced in trying to undertake stimulative monetary policy action when domestic interest rates were already at or close to zero. Price deflation, coupled with the zero bound, limited the ability of the Bank of Japan to reduce real interest rates and thereby stimulate the domestic economy. Targeting a zero rate of inflation, some observers suggest, would increase the likelihood of falling into such a "liquidity trap."

5. Some pensions are indexed, including the Canada Pension Plan and Old Age Security.

6. The measurement-error argument is based on the assumption that the errors are, on average, relatively large and positive, causing existing price indexes, such as the CPI, to overstate the true cost of living. Targeting an inflation rate that is too low could therefore create an unintended deflationary bias and move the economy away from true price stability.

7. See also Crawford (1998).

8. Akerlof et al. (1996), Fortin (1996), and Fortin et al. (2002) claim that targeting a rate of inflation that was too low might inhibit necessary adjustments in real wages. Targeting inflation rates lower than 3 to 4 per cent, they argued, could, therefore, raise the average unemployment rate and reduce potential output. Research at the Bank of Canada and elsewhere has shown that, while downward nominal wage rigidities do exist, they are not economically significant. In other words, the employment and output consequences of these rigidities are essentially undetectable. See Crawford and Wright (2001) and Bank of Canada (2001b).

In light of these concerns, research has been undertaken on several fronts addressing how to avoid such a situation. Some researchers have suggested that Japan might not have fallen into a liquidity trap if it had had an explicit inflation or price-level target (Svensson 2001). A second line of research has explored the use of alternative policy instruments to help stimulate the economy even if it does fall into a liquidity trap. The judgment that emerged was that the problems posed by the zero bound could be effectively mitigated by monetary policy communication to affect expectations of future policy interest rates and by open-market operations over a broader range of securities (Bernanke et al. 2004). At the same time, it was recognized that there is uncertainty about the effects of monetary policy at or very close to the zero bound. The third area of research focuses on the effect that price-level targeting might have on inflation expectations. Recent work suggests that the risks of hitting the zero bound on interest rates could be materially reduced if a lower inflation objective were combined with a target path for the price level. In other words, the two initiatives working together could help overcome the problem that might otherwise be posed by having inflation "too low" (Eggertsson and Woodford 2003; Wolman 2003).

3.2 Targeting a price level

The main difference between price-level targeting and inflation targeting is the way in which past deviations from the target are treated. Inflation targeting, as it is currently practised, effectively ignores past deviations from the target—that is bygones are bygones. It allows "one-off" price-level movements and aims only at bringing future (i.e., projected) inflation back to the target. In contrast, with a price-level target (which could rise over time), the short-run inflation objective would be adjusted from time to time in order to unwind any cumulative deviations of the actual price level from the target price level that had occurred. If the actual price level were below (or above) the price-level target, the central bank would have to aim for a slightly higher (or lower) inflation rate over a period of time in order to bring the actual price level back to the target.[9] If the actual price level corresponded to the targeted level, however, there would be no need to adjust the short-run inflation objective.

With an inflation target, the average rate of inflation should converge towards the target rate over the long run, provided that the shocks hitting the economy are random and that the central bank consistently aims for the target. But uncertainty about the future price level will, nevertheless, rise without limit as the planning horizon is lengthened, since there is no attempt in an inflation-targeting regime to return the price level to a specified path. This uncertainty could be contained if central banks targeted the price level directly and committed to offsetting over time any unexpected deviations or drift in one direction with future price movements in the other.

By providing households and businesses with greater certainty about the price level well into the future, price-level targeting might reduce the risks associated with entering into long-term financial obligations and could improve overall economic well-being by minimizing a source of unnecessary uncertainty. This could prove particularly beneficial for the increasing number of retirees on fixed incomes. Whether the benefits from greater price-level certainty are significant is the subject of ongoing research, as are the costs that might be associated with trying to pursue a price-level strategy (Batini and Yates 2003; Vestin 2006; Berg and Jonung 1999).

Several issues have been raised with regard to adopting some form of price-level targeting. One relates to the difficulty that might be associated with explaining price-level targeting to the general public. A clear understanding of the monetary policy objective and of the central bank's commitment to achieving it are two critical elements of any targeting arrangement, since expectations of future price movements play such an important role in the transmission of monetary policy.

Another issue is the concern that targeting a price level would induce larger fluctuations in output. Reversing past deviations of the price level from its target could require stimulating the economy beyond its capacity limits, or dampening activity to generate excess supply. Thus, even if the central bank succeeded in achieving its price-level objective, there might still be a cost in the form of increased variability in output and employment, which could outweigh any direct benefit from reduced

9. Compared with the six-to-eight-quarter horizon used for inflation targeting, some preliminary research suggests that the horizon for price-level targeting would be three to four years (Smets 2003).

price-level uncertainty. The problems confronting policy-makers could become even more challenging in the event of a series of large relative price shocks, such as a persistent increase in energy prices. This could require substantial offsetting decreases in other prices to bring the total CPI in line.[10]

Some research, however, suggests that price-level targeting might actually lead to smaller business cycles (Svensson 1999; Ball, Mankiw, and Reis 2005). Provided that the price-level target was credible and well understood, the price expectations it would generate could reduce fluctuations in output and inflation. Shocks that pushed prices below the target level would lead households and businesses to expect prices to rise in the future in response to stimulative monetary policy aimed at returning the price level to target. Businesses and households would therefore accelerate their spending, reinforcing the central bank's effort and moderating the movements in output. The same process would operate when shocks pushed prices above the target, but in reverse.

With price-level expectations better anchored, the movements in nominal interest rates required to redirect economic activity would also be smaller.[11] Combined with the self-stabilizing properties of a credible price-level target, this would, in turn, help to address the problem posed by the zero bound on nominal interest rates, giving policy-makers more scope to deal with negative shocks in a low-inflation environment than they otherwise might enjoy.

****

It is evident from this discussion that there are a number of important issues and questions that need to be addressed as part of the Bank's planned research program. Some of the specific questions that will be examined include:

1) How large are the improvements in economic welfare from having a lower targeted rate of inflation, and how might they be affected by the zero bound on interest rates? Are there practical ways to avoid or minimize the zero-bound problem?
2) What are the key frictions that give rise to transition costs as the economy moves from one targeted inflation rate to another, lower one, or from an inflation target to a price-level target? How large are these costs, and how can they be minimized?
3) What are the benefits of reduced price-level uncertainty? What are the potential welfare gains from price-level targeting, especially in regard to facilitating long-term investment decisions and the use of long-term, nominal-debt contracts? Would price-level targeting help address the zero-bound problem in an important way?
4) What are the relative merits of inflation targeting versus price-level targeting in an open economy susceptible to large and persistent terms-of-trade shocks? Can models of the global economy help quantify some of the benefits and costs? Which price index should be targeted?
5) To what extent should the choice of monetary policy framework in an open economy, such as Canada, be influenced by the choice of monetary policy framework in other countries (e.g., the United States)? Does this affect the balance of benefits and costs associated with price-level targeting versus inflation targeting?

The research effort undertaken by the Bank will address these questions, as well any necessary reassessment of issues covered in the past, and any new issues that may arise. The Bank invites other researchers to join in this effort. As indicated in the introduction, the goal is to complete this research well before 2011 so as to ensure sufficient time for open discussion of the results and their implications. We do not know what answers will emerge, but we do know that the results and conclusions will be more robust if they have been subjected to open, thorough, and vigorous debate among research economists and others with an interest in these issues and questions.

10. This assumes that total CPI (or total CPI ex indirect taxes) would remain the targeted index. Some research has indicated that other price indexes might be more appropriate in a price-level targeting regime.

11. More specifically, the real interest rate would rise more than the nominal interest rate when prices rose above target, and would fall more than the nominal rate when prices dropped below target.

References

Akerlof, G., W. Dickens, and G. Perry. 1996. "The Macroeconomics of Low Inflation." *Brookings Papers on Economic Activity* 1: 1–59.

Armour, J. 2006. "An Evaluation of Core Inflation Measures." Bank of Canada Working Paper No. 2006–10.

Armour, J. and T. Laflèche. 2006. "Evaluating Measures of Core Inflation." *Bank of Canada Review* (Summer): 19–29.

Ball, L., N.G. Mankiw, and R. Reis. 2005. "Monetary Policy for Inattentive Economies." *Journal of Monetary Economics* 52: 703–25.

Bank of Canada. 2001a. *Renewal of the Inflation-Control Target: Background Information*. Ottawa: Bank of Canada, May. Reprinted in the *Bank of Canada Review* (Summer 2001): 59–63.

———. 2001b. "Technical Background Document 1: A Brief Review of the Literature on Whether a Low-Inflation Regime Leads to Economic Difficulties." Ottawa: Bank of Canada, May. Reprinted in the *Bank of Canada Review* (Summer 2001): 64–66.

Batini, N. and T. Yates. 2003. "Hybrid Inflation and Price-Level Targeting." *Journal of Money, Credit and Banking* 35: 283–300.

Berg, C. and L. Jonung. 1999. "Pioneering Price Level Targeting: The Swedish Experience 1931–1937." *Journal of Monetary Economics* 43: 525–51.

Bernanke, B., V. Reinhart, and B. Sack. 2004. "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment." Federal Reserve Board Finance and Economics Discussion Series No. 2004–48.

Coletti, D., J. Selody, and C. Wilkins. 2006. "Another Look at the Inflation-Targeting Horizon." *Bank of Canada Review* (Summer): 31–37.

Crawford, A. 1998. "Measurement Biases in the Canadian CPI: An Update." *Bank of Canada Review* (Spring): 39–56.

Crawford, A. and G. Wright. 2001. "Downward Nominal-Wage Rigidity: Micro Evidence from Tobit Models." Bank of Canada Working Paper No. 2001–7.

Eggertsson, G. and M. Woodford. 2003. "The Zero Bound on Interest Rates and Optimal Monetary Policy." *Brookings Papers on Economic Activity* 1: 139–211.

Fortin, P. 1996. "The Great Canadian Slump." *Canadian Journal of Economics* 29: 761–87.

Fortin, P., G. Akerlof, W. Dickens, and G. Perry. 2002. "Inflation and Unemployment in the U.S. and Canada: A Common Framework." Département des sciences économiques, Université du Québec à Montréal Working Paper No. 20–16.

Jenkins, P. and B. O'Reilly. 2001. "Monetary Policy and the Economic Well-Being of Canadians." *The Review of Economic Performance and Social Progress*. Institute for Research on Public Policy.

Laidler, D. 2004. "Sticking to its Knitting: Why the Bank of Canada Should Focus on Inflation Control, Not Financial Stability." C.D. Howe Institute Commentary No. 196.

Levin, A., F. Natalucci, and J. Piger. 2004. "Explicit Inflation Objectives and Macroeconomic Outcomes." European Central Bank Working Paper No. 383.

Longworth, D. 2002. "Inflation and the Macroeconomy: Changes from the 1980s to the 1990s." *Bank of Canada Review* (Spring): 3–18.

Macklem, T. 2001. "A New Measure of Core Inflation." *Bank of Canada Review* (Autumn): 3–12.

Ragan, C. 1998. "On the Believable Benefits of Low Inflation." Bank of Canada Working Paper No. 98–15.

Reid, C., F. Dion, and I. Christensen. 2004. "Real Return Bonds: Monetary Policy Credibility and Short-Term Inflation Forecasting." *Bank of Canada Review* (Autumn): 15–26.

Rossiter, J. 2005. "Measurement Bias in the Canadian Consumer Price Index." Bank of Canada Working Paper No. 2005–39.

Selody, J. and C. Wilkins. 2004. "Asset Prices and Monetary Policy: A Canadian Perspective on the Issues." *Bank of Canada Review* (Autumn): 3–13.

References (cont'd)

Smets, F. 2003. "Maintaining Price Stability: How Long is the Medium Term?" *Journal of Monetary Economics* 50: 1293–1309.

Svensson, L.E.O. 1999. "Price-Level Targeting versus Inflation Targeting: A Free Lunch?" *Journal of Money, Credit and Banking* 31: 277–95.

———. 2001. "The Zero Bound in an Open Economy: A Foolproof Way of Escaping from a Liquidity Trap." Bank of Japan. *Monetary and Economic Studies* 19 (S–1): 277–312.

Tetlow, R. 2006. "Monetary Policy, Asset Prices, and Misspecification." In *Issues in Inflation Targeting*, 155–83. Proceedings of a conference held by the Bank of Canada. Ottawa: Bank of Canada, April 2005.

Vestin, D. 2006. "Price-Level versus Inflation Targeting." *Journal of Monetary Economics* 53: 1361–76.

Wolman, A.L. 2003. "Real Implications of the Zero Bound on Nominal Interest Rates." Federal Reserve Bank of Richmond Working Paper No. 03–15. (Forthcoming in *Journal of Money, Credit and Banking*.)

Bank of Canada Publications

For further information, including subscription prices, contact Publications Distribution, Communications Department, Bank of Canada, Ottawa, K1A 0G9 (Telephone: 613 782-8248).

Annual Report (published in March each year)*

Monetary Policy Report (published semi-annually)*

Monetary Policy Report Update (published in January and July)*

Financial System Review (published in June and December)*

Bank of Canada Review (published quarterly, see page 2 for subscription information)*

Speeches and Statements by the Governor*

Bank of Canada Banking and Financial Statistics (published monthly, see page 2 for subscription information)

Weekly Financial Statistics (published each Friday, available by mail through subscription)*

Renewal of the Inflation-Control Target: Background Information*

The Thiessen Lectures*

A History of the Canadian Dollar
James Powell (2nd edition published December 2005, available at Can$8 plus GST and PST, where applicable)

The Transmission of Monetary Policy in Canada (published in 1996, available at Can$20 plus GST and PST, where applicable)*

Bilingualism at the Bank of Canada (published annually)*

Bank of Canada Publications Catalogue, 2006*
A collection of short abstracts of articles and research papers published in 2006. Includes a listing of work by Bank economists published in outside journals and proceedings.

Planning an Evolution: The Story of the Canadian Payments Association, 1980–2002
James F. Dingle (published June 2003)*

About the Bank (published March 2004)*

Conference Proceedings*

Price Stability, Inflation Targets, and Monetary Policy, May 1997

Information in Financial Asset Prices, May 1998

Money, Monetary Policy, and Transmission Mechanisms, November 1999

Price Stability and the Long-Run Target for Monetary Policy, June 2000

Revisiting the Case for Flexible Exchange Rates, November 2000

Financial Market Structure and Dynamics, November 2001

Price Adjustment and Monetary Policy, November 2002

Macroeconomics, Monetary Policy, and Financial Stability A Festschrift in Honour of Charles Freedman, June 2003

The Evolving Financial System and Public Policy, December 2003

Canada in the Global Economy, November 2004

Issues in Inflation Targeting, April 2005

Inflation Targeting: Problems and Opportunities, February 2006

Fixed Income Markets, May 2006

Conference volumes published up to and including April 2005 are available at Can$15 plus GST and PST, where applicable.

Technical Reports and Working Papers*

Technical Reports and Working Papers are usually published in the original language only, with an abstract in both official languages. Single copies may be obtained without charge from: Publications Distribution, Communications Department, Bank of Canada, Ottawa, Ontario, KlA 0G9.
Technical Reports dating back to 1982 are available on the Bank's website, as are Working Papers back to 1994. Consult the April 1988 issue of the *Bank of Canada Review* for a list of Technical Reports and Staff Research Studies published prior to 1982.

* These publications are available on the Bank's website, **www.bankofcanada.ca**

Technical Reports*

2001

89 Core Inflation
(S. Hogan, M. Johnson, and T. Laflèche)

2002

90 Dollarization in Canada: The Buck Stops There
(J. Murray and J. Powell)

91 The Financial Services Sector:
An Update on Recent Developments
(C. Freedman and C. Goodlet)

92 The Performance and Robustness of Simple Monetary Policy Rules in Models of the Canadian Economy
(D. Côté, J. Kuszczak, J.-P. Lam, Y. Liu, and P. St-Amant)

2003

93 Money in the Bank (of Canada)
(D. Longworth)

94 A Comparison of Twelve Macroeconomic Models of the Canadian Economy
(D. Côté, J. Kuszczak, J.-P. Lam, Y. Liu, and P. St-Amant)

95 Essays on Financial Stability
(J. Chant, A. Lai, M. Illing, and F. Daniel)

2005

96 MUSE: The Bank of Canada's New Projection Model of the U.S. Economy
(M.-A. Gosselin and R. Lalonde)

2006

97 ToTEM: The Bank of Canada's New Quarterly Projection Model
(S. Murchison and A. Rennison)

Working Papers*

2006

1 The Institutional and Political Determinants of Fiscal Adjustment
(R. Lavigne)

2 Structural Change in Covariance and Exchange Rate Pass-Through: The Case of Canada
(L. Khalaf and M. Kichian)

3 Money and Credit Factors
(P. Gilbert and E. Meijer)

4. Forecasting Canadian Time Series with the New Keynesian Model
(A. Dib, M. Gammoudi, and K. Moran)

5 Are Currency Crises Low-State Equilibria? An Empirical, Three-Interest-Rate Model
(C. M. Cornell and R. H. Solomon)

6 Regime Shifts in the Indicator Properties of Narrow Money in Canada
(T. Chan, R. Djoudad, and J. Loi)

7 Ownership Concentration and Competition in Banking Markets
(A. Lai and R. Solomon)

8 A Structural Error-Correction Model of Best Prices and Depths in the Foreign Exchange Limit Order Market
(I. Lo and S. Sapp)

9 Monetary Policy in an Estimated DSGE Model with a Financial Accelerator
(I. Christensen and A. Dib)

10 An Evaluation of Core Inflation Measures
(J. Armour)

11 The Federal Reserve's Dual Mandate: A Time-Varying Monetary Policy Priority Index for the United States
(R. Lalonde and N. Parent)

12 The Welfare Implications of Inflation versus Price-Level Targeting in a Two-Sector, Small Open Economy
(E. Ortega and N. Rebei)

13 Guarding against Large Policy Errors under Model Uncertainty
(G. Cateau)

14 Forecasting Commodity Prices: GARCH, Jumps, and Mean Reversion
(J.-T. Bernard, L. Khalaf, M. Kichian, and S. McMahon)

15 LVTS, The Overnight Market, and Monetary Policy
(N. Kamhi)

16 Benchmark Index of Risk Appetite
(M. Misina)

17 Risk-Cost Frontier and Collateral Valuation in Securities Settlement Systems for Extreme Market Events
(A. Garcia and R. Gençay)

18 Working Time over the 20th Century
(A. Ueberfeldt)

19 Institutional Quality, Trade, and the Changing Distribution of World Income
(B. Desroches and M. Francis)

20 Examining the Trade-Off between Settlement Delay and Intraday Liquidity in Canada's LVTS: A Simulation Approach
(N. Arjani)

21 The International Monetary Fund's Balance-Sheet and Credit Risk
(R. Felushko and E. Santor)

22 Launching the NEUQ: The New European Union Quarterly Model, A Small Model of the Euro Area and U.K. Economies
(A. Piretti and C. St.-Arnaud)

23 Convergence in a Stochastic Dynamic Heckscher-Ohlin Model
(P. Chatterjee and M. Shukayev)

24 Are Average Growth Rate and Volatility Related?
(P. Chatterjee and M. Shukayev)

25 Linear and Threshold Forecasts of Output and Inflation with Stock and Housing Prices
(G. Tkacz and C. Wilkins)

26 Using Monthly Indicators to Predict Quarterly GDP
(I. Yi Zheng and J. Rossiter)

27 Can Affine Term Structure Models Help Us Predict Exchange Rates?
(A. Diez de los Rios)

28 Estimation of the Default Risk of Publicly Traded Canadian Companies
(G. Dionne, S. Laajimi, S. Mejri, and M. Petrescu)

29 The Turning Black Tide: Energy Prices and the Canadian Dollar
(R. Issa, R. Lafrance, and J. Murray)

30 Multinationals and Exchange Rate Pass-Through
(A. Lai and O. Secrieru)

* These publications are available on the Bank's website, **www.bankofcanada.ca**

Working Papers* (continued)

2006

31 Assessing and Valuing the Non-Linear Structure of Hedge Fund Returns
(A. Diez de los Rios and R. Garcia)

32 Governance and the IMF: Does the Fund Follow Corporate Best Practice?
(E. Santor)

33 Are Canadian Banks Efficient? A Canada–U.S. Comparison
(J. Allen, W. Engert, and Y. Liu)

34 The Macroeconomic Effects of Non-Zero Trend Inflation
(R. Amano, S. Ambler, and N. Rebei)

35 Survey of Price-Setting Behaviour of Canadian Companies
(D. Amirault, C. Kwan, and G. Wilkinson)

36 Credit in a Tiered Payments System
(A. Lai, N. Chande, and S. O'Connor)

37 Endogenous Borrowing Constraints and Consumption Volatility in a Small Open Economy
(C. de Resende)

38 Conditioning Information and Variance Bounds on Pricing Kernels with Higher-Order Moments: Theory and Evidence
(F. Chabi-Yo)

39 Short-Run and Long-Run Causality between Monetary Policy Variables and Stock Prices
(J.-M. Dufour and D. Tessier)

40 Education and Self-Employment: Changes in Earnings and Wealth Inequality
(Y. Terajima)

41 An Optimized Monetary Policy Rule for ToTEM
(J.-P. Cayen, A. Corbett, and P. Perrier)

42 Linking Real Activity and Financial Markets: The Bonds, Equity, and Money (BEAM) Model
(C. Gauthier and F. C. Li)

43 Efficient Hedging and Pricing of Equity-Linked Life Insurance Contracts on Several Risky Assets
(A. Melnikov and Y. Romanyuk)

44 The Long-Term Effects of Cross-Listing, Investor Recognition, and Ownership Structure on Valuation
(M. R. King and D. Segal)

45 The Role of Debt and Equity Finance over the Business Cycle
(F. Covas and W. J. den Haan)

46 Survey-Based Estimates of the Term Structure of Expected U.S. Inflation
(S. Kozicki and P.A. Tinsley)

47 Stress Testing the Corporate Loans Portfolio of the Canadian Banking Sector
(M. Misina, D. Tessier, and S. Dey)

48 Modelling Term-Structure Dynamics for Risk Management: A Practitioner's Perspective
(D. Bolder)

49 Canadian City Housing Prices and Urban Market Segmentation
(J. Allen, R. Amano, D. P. Byrne, and A. W. Gregory)

* These publications are available on the Bank's website, **www.bankofcanada.ca**