NAVIGATING TURBULENCE:
Canadian Monetary Policy Since 2004

Steve Ambler and Jeremy Kronick

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FOREWORD

Some 14 years have passed since the C. D. Howe Institute published *Two Percent Target: The Context, Theory and Practice of Canadian Monetary Policy since 1991*. In that book, David Laidler and I chronicled the transition from a turbulent period when monetary policy was highly contentious – not least because of the recessionary impact of efforts to bring inflation down – to a calmer period in which the Bank of Canada had gained considerable operational autonomy, and had used it to successfully target low inflation for many years running.

The story that Steve Ambler, Professor of Economics at the Université du Québec and David Dodge Chair in Monetary Policy at the C.D. Howe Institute, and Jeremy Kronick, Associate Director, Research at the Institute, pick up in the mid-2000s is different in many ways. The 2008 financial crisis is widely seen as a failure of macroeconomic policy, and the response of central banks in Canada and abroad to the crisis itself and the recession that followed it took them into uncharted territory. Yet, as Ambler and Kronick detail in the pages that follow, key elements of the Bank of Canada's strategy and tactics continued through the crisis and recession, and during the years of disappointing growth, under-target inflation and very low interest rates that followed.

The Bank of Canada still targets two percent inflation, and the variability of inflation around that target continues to be less than most people expected in the run-up to, and early days of, targeting. The Bank still implements monetary policy by setting a corridor for its short-term policy interest rate, the overnight rate. The Canadian dollar continues to float freely. And while financial stability has a higher profile among the Bank's concerns than it did, the primacy of low and stable inflation in its goals remains.

Readers interested in Canada's economic performance since the early 2000s generally, and the conduct of monetary policy in particular, will find a wealth of information and insights in Ambler and Kronick's work. They review the theory and practice of the Bank of Canada's responses to economic circumstances, take the reader through the "great moderation," the crisis and recession, and the slow recovery that followed, explore how the Bank reacted and reformulated its policies in response to these events, and close with discussions of such outstanding issues as the future of inflation targeting, liquidity provision in a crisis, and how housing and demographic change may affect monetary policy in the future.

It is a particular pleasure to acknowledge the contribution Ambler and Kronick make with this book to the C.D. Howe Institute's continuing efforts to document and explain the role of monetary policy in Canada's economic development. Along with other reports that sought to explain how Canadian monetary policy works and affects the economy, and promote discussion of how the Bank of Canada's goals and tactics might improve, the Institute has published a series of major studies documenting what has happened, and why, and what lessons we can draw for the future. From Thomas J. Courchene's *Money, Inflation and the Bank of Canada: An analysis of Canadian Monetary Policy from 1970 to early 1975* and its successor covering the later 1970s, through Peter Howitt's *Monetary Policy in Transition: A Study of Bank of Canada Policy, 1982–1985*, to David Laidler and my *The Great Canadian*

Disinflation: The Economics and Politics of Monetary Policy in Canada 1988-93 and *Two Percent Target*, the Institute has a long tradition of chronicling Canadian monetary policy. We trust that Steve Ambler and Jeremy Kronick's contribution will be a valued resource to experts, students, and any Canadians interested in how their central bank affects their economy for years to come.

While the analysis and opinions presented here are the responsibility of its authors, and do not necessarily represent the views of the Institute's members or Board of Directors, this book exemplifies the C. D. Howe Institute's mission to foster informed discussion on key economic policy topics through sound analysis and careful empirical research.

William B.P. Robson

President and Chief Executive Officer

PREFACE

This book is part of a series of volumes the C.D. Howe Institute has published on monetary policy in Canada. Fourteen years have passed since the publication of the previous volume in this series: *Two Percent Target: The Context, Theory, and Practice of Canadian Monetary Policy since 1991*, by David Laidler and William B.P. Robson, winner of the 2004 Donner Prize for excellence in writing on Canadian public policy.[1] Our narrative therefore begins in 2004, and continues up to the end of 2017.

The Bank of Canada says the primary objective of its monetary policy "is to preserve the value of money by keeping inflation low, stable and predictable."[2] This is relatively uncontroversial, but the best means of achieving this goal, and the exact nature of the benefits derived from low, stable inflation, are more complicated. Also, the preamble to the *Bank of Canada Act* (Canada 2018, 1) considerably broadens the Bank's remit "to mitigate by its influence fluctuations in the general level of production, trade, prices and employment,

1 In addition to Laidler and Robson (2004), previous volumes in the series were Courchene (1976, 1981); Howitt (1986); and Laidler and Robson (1993).

2 Bank of Canada, "Monetary Policy," n.d., http://www.bankofcanada.ca/core-functions/monetary-policy/.

so far as may be possible within the scope of monetary action, and generally to promote the economic and financial welfare of Canada." In this sense, the goal of stabilizing real output and employment is compatible with the Bank's current monetary framework of inflation targeting as it is generally understood. There is much evidence to support the importance of the effect of monetary policy on the real economy in the short run, and the events we describe in this book serve to confirm this importance.[3] We provide detailed explanations of how the Bank of Canada has used its monetary policy tools to achieve these goals, and we discuss what issues lie ahead.

The defining macroeconomic event during the period covered by this volume – giving rise to the "turbulence" of our title – was the financial crisis of 2007–08, which was followed by the recession of 2008–09, the only one Canada has experienced since 2004.[4] For Canada, that recession was not exceptional by historical standards, but in the United States and some other industrial countries it was the deepest and longest since the Great Depression of the 1930s. For this reason it has been dubbed the Great Recession.

The book is divided into four main Parts. Part I provides a general overview. Chapter 1 summarizes the evolution of the Canadian economy during the period covered by the book. Chapter

3 Clarida, Galí, and Gertler (1999, 1661) note: "[A]fter a long period of near exclusive focus on the role of non-monetary factors in the business cycle, a stream of empirical work beginning in the late 1980s has made the case that monetary policy significantly influences the short-term course of the real economy."

4 Canada experienced two consecutive quarters of negative economic growth in the first half of 2015, which some would classify as a "technical recession." The downturn was restricted, however, to a few industries, and employment actually expanded during this period, leading the C.D. Howe Institute's Business Cycle Council to judge that the episode was not widespread enough to be termed a recession, subject to final revisions by Statistics Canada (in 2018) of the data on gross domestic product for 2015. See C.D. Howe Business Cycle Council (2015, 2016) for more details.

2 reviews the Bank of Canada's inflation targeting framework and looks at how the Bank conducts monetary policy to achieve its objectives and how changes in monetary policy affect inflation and economic activity. Chapter 3 discusses the theoretical underpinnings of the Bank's monetary policy framework and how macroeconomic theory and the practice of monetary policy have evolved over time. Chapter 4 examines the so-called Great Moderation that preceded the 2007 financial crisis. It documents the relative stability of inflation and economic activity and looks at whether this stability can be attributed to luck or good monetary policy management.

Part II deals with the financial crisis and the Great Recession. In Chapter 5 we document how the financial crisis and subsequent recession unfolded in Canada, including the evolution of inflation during the recession. Chapter 6 analyzes the Bank's reaction to the crisis, looking both at its use of monetary policy to stabilize inflation and output, and at its provision of liquidity to the financial system to dampen the effects of the crisis on Canada's financial sector.

In Part III we look at the recovery from the recession, which has been long and slow both in Canada and abroad. Chapter 7 documents the slow pace of the recovery in industrialized countries, and discusses some of the explanations researchers have proposed to explain this phenomenon. One of the characteristics of the world economy since the Great Recession is low interest rates. Chapter 8 examines the challenges a low-interest-rate world poses for monetary policy. Chapter 9 looks at the most significant Canadian macroeconomic development since the recovery from the Great Recession began, the crash in oil prices in 2014 which caused negative real economic growth in Canada in the first half of 2015. We look in detail at the difficulties of conducting monetary policy in a resource-rich economy. Chapter 10 looks at the run-up to the 2016 renewal of the inflation-control agreement between the Bank and the Government of Canada. We examine the main issues of concern to the Bank and look at why the inflation-targeting framework was renewed with only minor tweaks.

Part IV looks at some issues that will affect the conduct of Canada's monetary policy in the future and which may influence the shape of the next renewal in 2021. Chapter 11 looks in detail at issues related to the Bank's provision of liquidity to the financial sector. Chapter 12 discusses the importance of the housing sector and household indebtedness in the Canadian economy, and its relevance for the conduct of monetary policy, and also examines the impact Canada's aging population will have on the effectiveness of Canada's monetary policy.

The book is primarily narrative and descriptive, but we do take stances on policy issues. Like our predecessors in this series, we believe that monetary aggregates – and therefore factors affecting the supply of, and demand for, money – are important for the transmission of monetary policy. The Bank of Canada's paradigm for the conduct of monetary policy has led it to reduce gradually the attention it pays to monetary aggregates. The Bank's *Monetary Policy Report,* for example, no longer includes discussions about the evolution of monetary aggregates, even as predictors of future inflation. It is our contention, however, that the successful conduct of monetary policy in today's low-interest-rate environment means giving a greater role to money – in particular, a greater role for quantitative easing.

Furthermore, we argue that the Bank of Canada's role in promoting financial stability should be primarily an advisory one. Giving the Bank primary responsibility for financial stability would lead it down the path of making decisions concerning credit allocation and fiscal policy, thereby jeopardizing its independence. The Bank of Canada, along with other central banks, does have a role to play as lender of last resort (or market maker of last resort). It has rightly favoured using market mechanisms as much as possible to provide liquidity to the banking system as a whole. It should continue to operate in this manner, and refine the criteria it has laid out to avoid the temptation to allocate credit to specific firms and sectors.

The book contains much material that is new, but it also draws on our previous work and that of our predecessors in this series. We owe a particular debt of gratitude to many people, including the Oesterreichische Nationalbank, where Steve Ambler was on sabbatical during the early phases of drafting this book, for providing a productive research environment; William B.P. Robson and the many colleagues at the C.D. Howe Institute who provided advice and comments on drafts; and Daniel Schwanen, who provided insightful comments and carefully synthesized those of a large number of external reviewers. We particularly thank the following external reviewers for their detailed and invaluable comments and suggestions: John Crow, David Dodge, Pierre Duguay, Thorsten Koeppl, David Laidler, Angelo Melino, and John David Murray. In particular, we would like to highlight the contribution of David Longworth who reviewed the book twice. Thanks also to Barry Norris for applying his excellent editing skills to the text and to Yang Zhao for designing and producing the book. All remaining errors are the sole responsibility of the authors – a caveat that is particularly important given our judgments concerning the conduct of monetary policy.

Steve Ambler
Jeremy Kronick

PART I

Introduction and Overview

Chapter 1

An Overview of the Canadian Economy since 2004

A brief outline of major developments in the Canadian economy since 2004 will help anchor our narrative. In this chapter, we review major developments in output, employment, unemployment, inflation, oil prices and the federal government's fiscal position. We then link Canadian monetary policy, through a discussion on interest rates and monetary aggregates, with these macroeconomic variables.

Output, Employment and Unemployment

The period from 2004 until the start of the recession in 2008, the tail end of a period which has become known as the Great Moderation, was characterized by relatively mild fluctuations in output, employment, unemployment and inflation, not only in Canada, but also in the world's other industrialized economies. We can see this phenomenon clearly in Figure 1.1, with quarterly real GDP growth nearly always growing between zero and 1 percent until 2008. The Great Moderation came to an end with the Great Recession of 2008–09. Unlike the brief periods of negative GDP growth in 2001, 2003, 2015 and 2016,[1] which were not significant or sustained enough to be classified as recessions, during the Great Recession GDP fell at a significant clip (Figure 1.1), while the output gap (the difference between actual and potential output) turned significantly negative (Figure 1.2) and labour market variables tumbled (Figures 1.3–1.4).[2] We document the facts of the 2008–09 recession in more detail in Chapter 6, and compare it both to previous Canadian recessions and to those elsewhere in the world. In some industrialized economies, the Great Recession was the most severe economic downturn since the Great Depression of the 1930s.

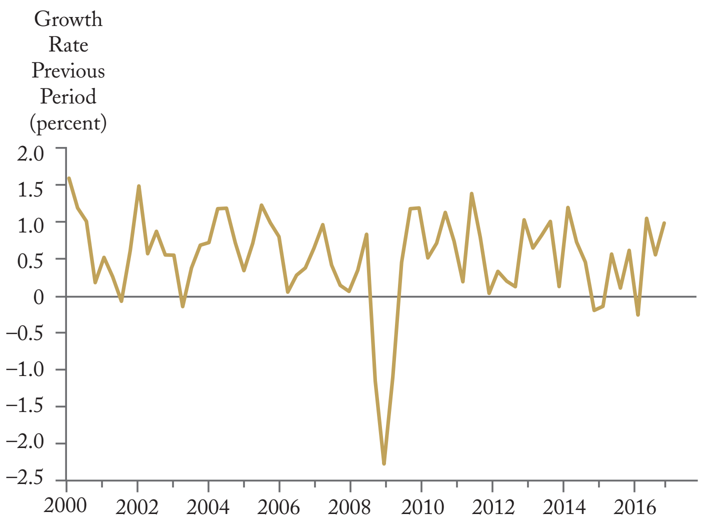
In Canada, the recession was relatively mild by historical and international standards, but the recovery has been quite sluggish, as can be discerned in Figures 1.2 and 1.4. According to a Bank of Canada measure of the output gap, except for a very brief period in 2011 the Canadian economy has been running at excess capacity since the end of the Great Recession. In addition, unemployment has been falling only gradually – only in December 2017 did the unemployment rate hit the level attained just before the recession began. These pressures have resulted in headline inflation below the midpoint of the Bank's target range.[3]

1 At the time of writing, definitive (revised) data on GDP for 2015 still had not been released. Accordingly, the C.D. Howe Institute's Business Cycle Council determined that it was too early to classify this particular downturn as a recession (see C.D. Howe Business Cycle Council 2016).

2 A recession is defined as a significant, widespread and sustained decline in economic activity. Negative GDP growth is an important factor in determining whether or not an economy is in recession, but it is not the only factor, as detailed in Cross and Bergevin (2012) and Kronick (2016c).

3 Headline inflation is defined as the year-on-year change in the consumer price index (CPI), which measures the cost of a fixed basket of goods and services purchased by consumers.

Figure 1.1: Quarterly Real GDP Growth, Canada, 2000–17

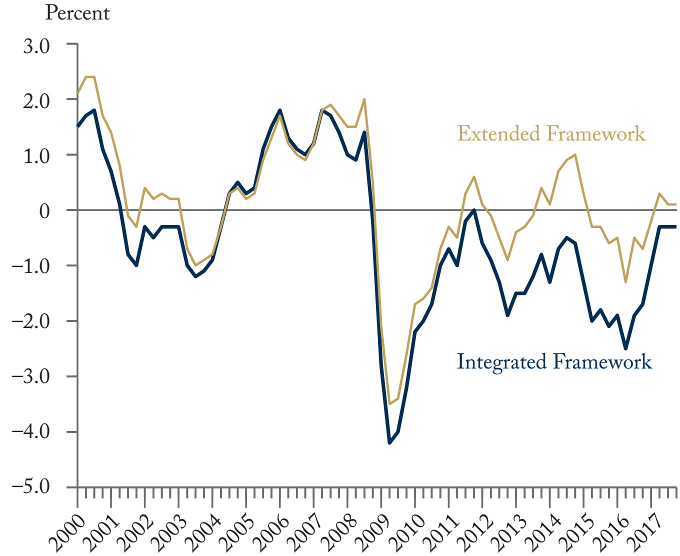


Source: Statistics Canada, CANSIM table 380 0064.

The sluggishness of the recovery is one of the puzzling features of the period we study. A comparison with the recovery of the Canadian economy from the Great Depression is instructive. As Figure 1.5 shows, although the cumulative change in Canada's GDP ten years after the Great Recession was above where it was ten years following the Great Depression, the rate of recovery was much lower. If the current trend continues, cumulative growth since the start of the Great Depression will have overtaken growth since the start of the Great Recession by year eleven (2018). Explaining this sluggish recovery and the extent to which monetary policy might be contributing to it is a central theme of Part III of the book.[4]

4 Blanchard and Summers (2017) document a similar phenomenon for the US economy.

Figure 1.2: The Output Gap, Canada, 2000–17



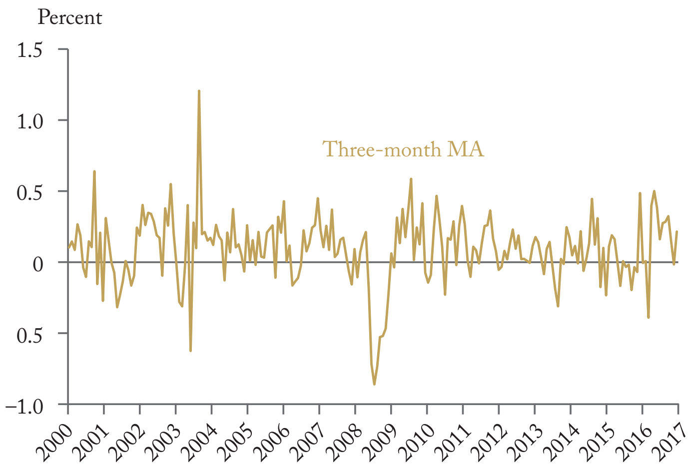
Note: The extended multivariate filter uses purely statistical methods to smooth actual output growth in order to generate a smoothed measure that is taken to be potential output; the integrated framework looks at trend growth in labour inputs and labour productivity. See Pichette et al. (2015).
Source: Bank of Canada.

Inflation

In many respects, inflation was both a great success story and a major puzzle during the period we cover in this book. The success story is that, as measured by the consumer price index (CPI), inflation remained within the Bank of Canada's target range of 1–3 percent for most of the period (Figure 1.6),[5] with three small spikes above

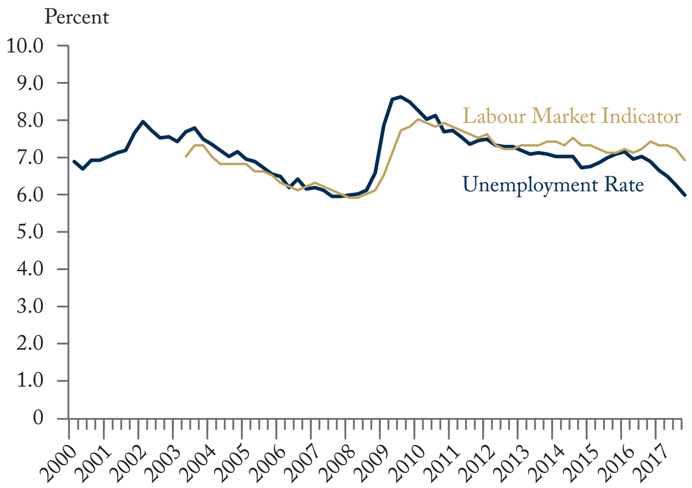
5 Inflation itself is measured by the year-on-year rate of change of the CPI. Until 2016, the Bank used a measure of core inflation that excluded a certain number of components that were judged to be more volatile. It has since adopted three new measures of core inflation: CPI-Trim, CPI-Median and CPI-Common (See Khan, Morel and Sabourin 2015 and Schembri 2017). We discuss the new measures of core inflation in more detail in Chapter 10.

Figure 1.3: Employment Growth in Total Hours, Canada, 2000–17



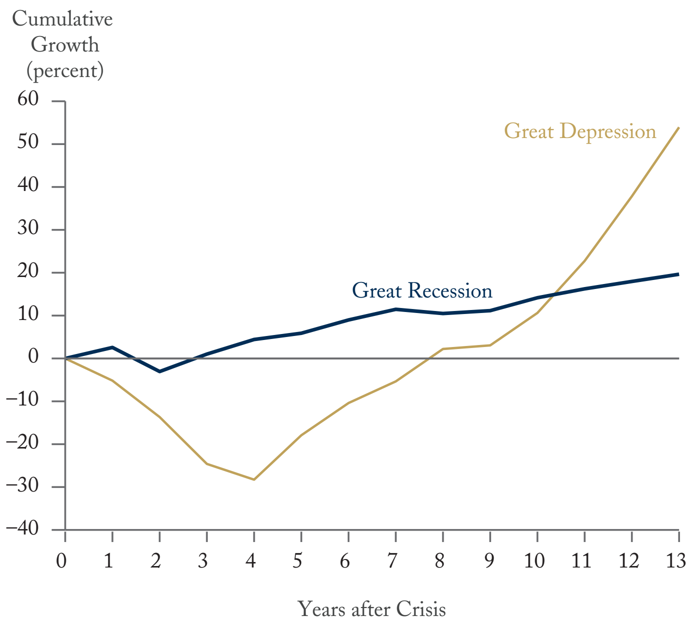
Note: Data are 3-month moving averages.
Source: Statistics Canada, CANSIM table 282 0092.

Figure 1.4: Unemployment Rate and Labour Market Index, Canada, 2000–17



Note: The labour market index summarizes the information in several different labour market measures; see Zimitrowicz and Khan (2014).
Source: Statistics Canada, CANSIM table 282 0087, and Bank of Canada.

Figure 1.5: Cumulative Growth in real GDP, Great Depression versus Great Recession, Canada

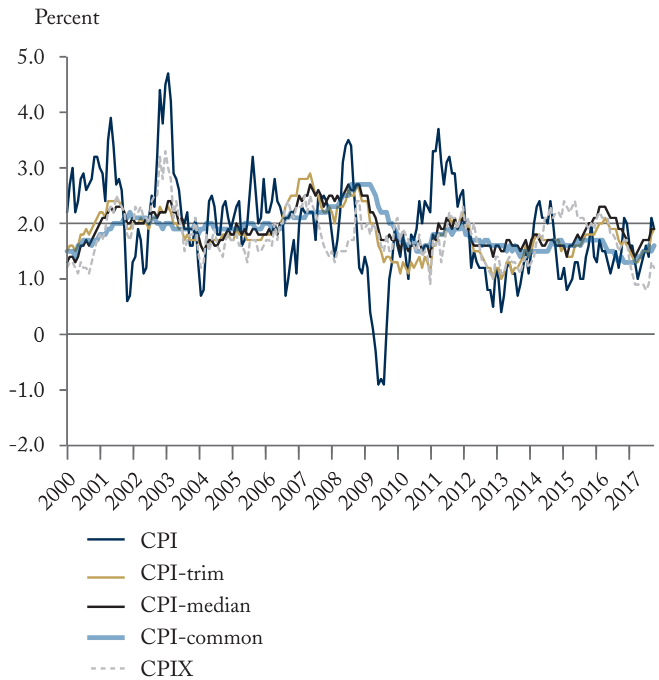


Note: Year zero is 1929 for Great Depression. Year zero is 2007 for Great Recession.
Source: Statistics Canada, CANSIM tables 380 0515, 380 0064, 326 0020.

3 percent since 2004 and two below 1 percent (the first of these two, associated with the financial crisis and recession, was the deepest and most prolonged). As a comparison of Figures 1.6 and 1.9 shows, the upward spikes in inflation in 2008 (before the start of the last recession) and in 2011 are related to increases in the world price of oil, while the downward spike in 2015 coincided with the collapse in world oil prices.

Despite this mostly positive story, the puzzle is that inflation remained stubbornly below the Bank of Canada's 2 percent target – indeed, since 2010, inflation has averaged a little over 1.6 percent.

Figure 1.6: CPI Inflation and Different Core Measures, Canada, 2000–17



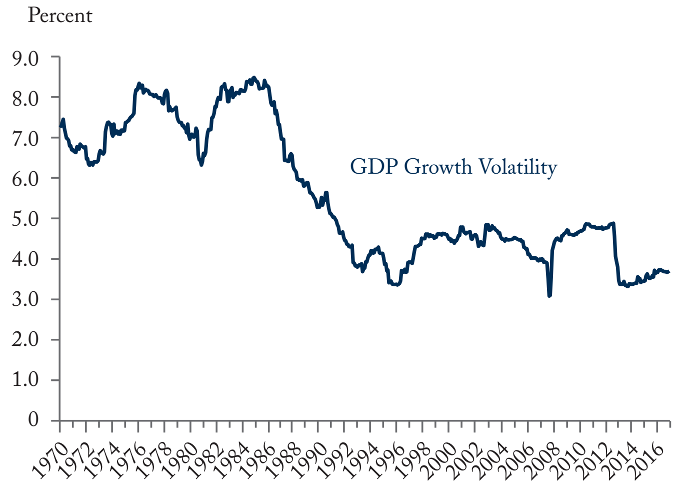
Note: Inflation is year over year change at monthly frequency.
Source: Bank of Canada.

Although that is within the Bank's 1–3 percent band, persistent deviations from the 2 percent target are not desirable. Inflation that is persistently away from target means that future prices will be harder for firms and consumers to predict, and the credibility of the target might also be undermined. The phenomenon is not unique to Canada, and there is now a fairly extensive literature on the subject.

The Volatility of Growth and Inflation

As noted above, the global Great Recession was preceded by the

Figure 1.7: Volatility of Real GDP Growth, Canada, 1970–2017

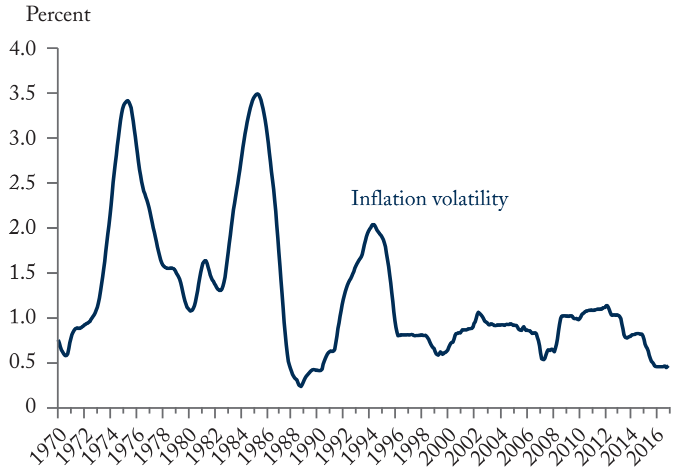


Sources: Authors' calculations where we use standard deviation of a 5-year moving average of annualized monthly growth; Statistics Canada, CANSIM table 379 0031.

Great Moderation in many advanced markets. This phenomenon also held in Canada, which experienced steady GDP growth and inflation from the mid-to-late 1990s until the onset of the Great Recession. We can see this clearly by looking at the evolution of five-year moving averages of GDP-growth volatility (Figure 1.7)[6]

6 Since GDP grows over time, it is necessary to use a transformation of GDP in levels so that averages and volatilities are not growing over time. Using the rate of growth is common practice. Using a measure of the output gap (the difference between actual output and its trend or its full-employment level) is also common and would lead to similar qualitative results. We use the rate of growth, in part because it allows the use of higher frequency monthly data.

Figure 1.8: Volatility of Inflation, Canada, 1970–2017

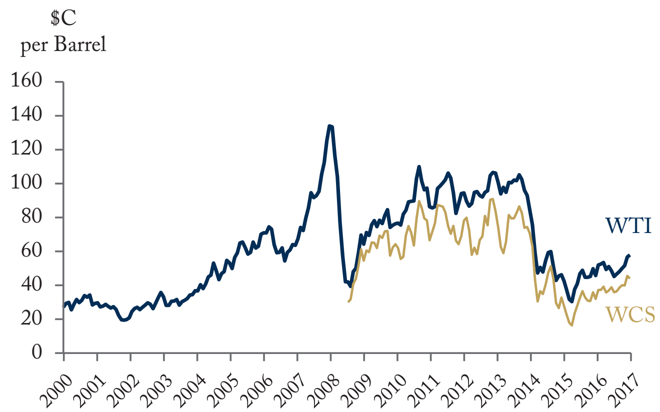


Sources: Authors' calculations where we use standard deviation of a 5-year moving average of year over year monthly inflation; Statistics Canada, CANSIM table 326 0022.

and of inflation volatility (Figure 1.8).[7] To show the long-lasting effects of the Great Moderation, we have extended the period covered by these graphs back to the early 1970s. In Chapter 4 we discuss to what extent these results can be attributed to good policy, as opposed to luck (in the form of a lack of major exogenous macroeconomic shocks).

7 The Bank of Canada's inflation target has been constant (2 percent) since 1996. For any five-year moving average within this period, the volatility of inflation is identical to the volatility of inflation around the target, as the latter would simply involve subtracting a constant (the target) from actual inflation. For the period between 1991 and 1996 the Bank gradually lowered the targeted inflation rate: within this period the volatility of inflation can differ from that of inflation around its target, but the differences are very small.

Figure 1.9: Crude Oil Prices, West Texas Intermediate and Western Canada Select, Monthly, 2000–17



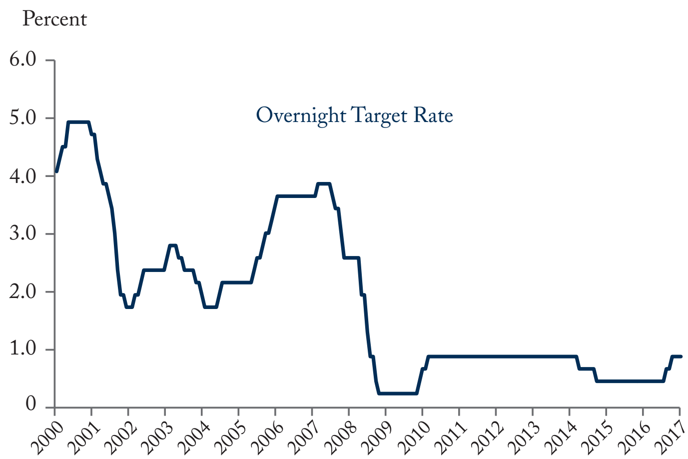
Note: WTI is a medium crude oil often used as a benchmark in global oil pricing. WCS is a heavy crude oil and is the benchmark for emerging heavy, high acidic crudes.
Source: US Federal Reserve.

Turning to the post-crisis era, although inflation volatility remained low, the volatility of GDP growth picked up. As we discuss in later chapters, the sensitivity of inflation to changes in output, a relationship known as the Phillips curve, seems to have decreased in recent years, and this is one possible explanation for these conflicting results.

Crude Oil Prices

Canada is a major producer and exporter of crude oil, natural gas and related products, but its output is small relative to world production, making Canada a price taker in world oil markets. Fluctuations in world oil prices are beyond Canada's control, but their economic impact is extremely important for the Canadian economy. The drastic decline in oil prices late in 2014 (Figure 1.9) led to two consecutive quarters of negative economic growth in

Figure 1.10: Bank of Canada's Overnight Target Rate, Monthly, 2000–17



Source: Statistics Canada, CANSIM table 176 0043.

2015 – a "technical recession," but not quite a true recession due to the narrow scope of the economic contraction. How Canadian monetary policy should respond to volatile commodity prices is another major theme of the book, which we take up in detail in Chapter 9.

The Bank of Canada's Overnight Rate

The evolution over time of the target of the Bank of Canada's overnight rate[8] gives an indication of how the central bank reacted to the changes in macroeconomic variables we have described (Figure 1.10). Two key characteristics of the path of the overnight rate stand out. The first is the rapid decline in the rate during the

8 The overnight rate is the interest rate at which major financial institutions borrow and lend one-day (or "overnight") funds among themselves.

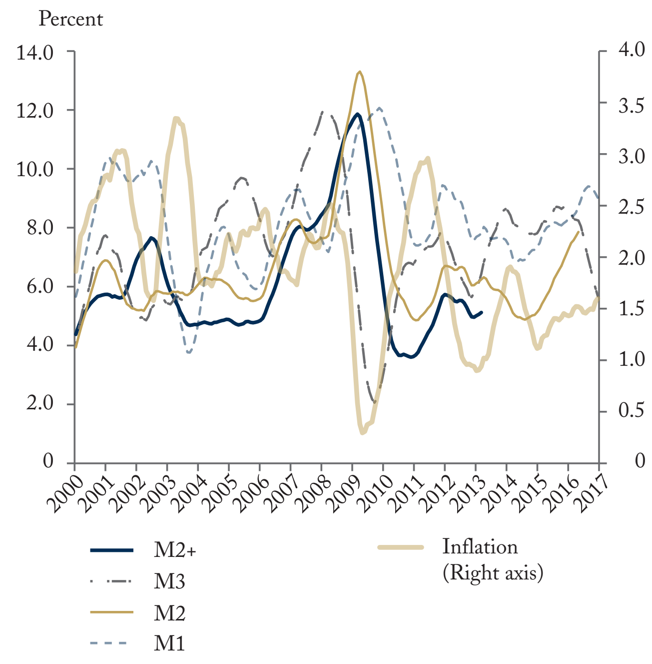
Great Recession. Declines in central bank policy rates are normal, and wholly appropriate, in recessions: temporarily low interest rates help boost inflation when it is below target and also helps boost real economic activity. This is exactly what the Bank did. During the recession, however, the overnight rate fell to what the Bank considered (at the time) to be its effective lower bound of 25 basis points. Once the Bank's policy rate hit the presumptive effective lower bound, it was not considered possible to make conventional monetary policy any more expansionary. As we discuss in Part III (particularly in Chapter 8), this led the Bank to consider the possibility of using different unconventional tools to provide stimulus to the economy.

The second striking characteristic is how much lower, on average, the overnight rate remained – not exceeding 125 basis points, and 325 basis points below its peak before the Great Recession began – compared with its historical average. Part of this was necessary, as the economy was not rebounding as hoped, and inflation remained below target. Remaining at this low level, however, leaves little room for the Bank of Canada to reduce its overnight rate in the face of future negative shocks such as the financial crisis that preceded the recession. Given sluggish inflation and the slow recovery of GDP, this new, low-interest-rate environment might well mean that the inflation-targeting paradigm that has worked well in Canada since the mid-1990s has either to be tweaked or substantially modified. We discuss this issue in detail in Chapter 8.

Canadian Monetary Aggregates

In a book dealing with Canadian monetary policy, it would be easy to assume that a discussion of monetary aggregates and supply and demand in the money market would be front and centre in the discussion. A cursory review, however, of the current academic literature on monetary policy and of central bank publications, including those of the Bank of Canada, quickly suggests otherwise.

Figure 1.11: Year-over-Year Growth Rates of Monetary Aggregates, Canada, 2000–17



Note: Data are 12-month moving averages.
Sources: Authors' calculations; Statistics Canada, CANSIM table 326 0020; OECD.

As we document in Chapter 3, the macroeconomic paradigm prevalent at the beginning of our period involved stabilizing fluctuations in inflation and output via the control of a short-term nominal interest rate (the Bank's target overnight rate, illustrated in Figure 1.10). The standard view of how the interest rate affects output and inflation by affecting aggregate demand leaves money almost entirely out of the story. The standard reference for this paradigm, Woodford's (2003) masterful *Interest and Prices*, discusses money primarily to argue why monetary aggregates are unnecessary for understanding the conduct of monetary policy and its effects.

However, two salient features of Canadian monetary aggregates during the period under analysis, along with the sluggish recovery in inflation, suggest the importance of monetary aggregates is perhaps understated (see Figure 1.11 and definitions of the different monetary aggregates in Box 1). First, money growth is closely related to inflation, especially M3, and in many cases leads inflation.[9] Second, the growth of monetary aggregates fluctuated over the period, but the drop in M3 at the beginning of the Great Recession was particularly pronounced, and mirrored that of inflation. We delve into this issue in greater detail in Chapter 3.

Additionally, one unconventional alternative to the use of the overnight rate target as the primary instrument of monetary policy is quantitative easing, which involves using changes in the money supply to affect spending, and thereby inflation and real economic activity. One of our goals throughout this book is to convince the reader that monetary aggregates still have an important role to play, not only as an indicator of future inflation, but also in the transmission of monetary policy via its effects on individuals' spending decisions and inflation expectations.

Federal and Provincial Government Budgetary Balances

Figure 1.12, which shows federal and (combined) provincial budgetary balances going back to 1991, tells a story of budget consolidation and debt reduction in the years before the Great Recession. The federal budget moved sharply into deficit territory during the recession itself, but the deficit never became as important a fraction of GDP as in the early 1990s.

9 The Bank of Canada no longer publishes its own statistics on M3. The time series for M3 comes from the Organisation for Economic Co-operation and Development, which calculates statistics for broad money from data supplied by the Bank and Statistics Canada.

Box 1: Definitions of Monetary Aggregates

Narrow monetary aggregates, as defined by the Bank of Canada, include the following:

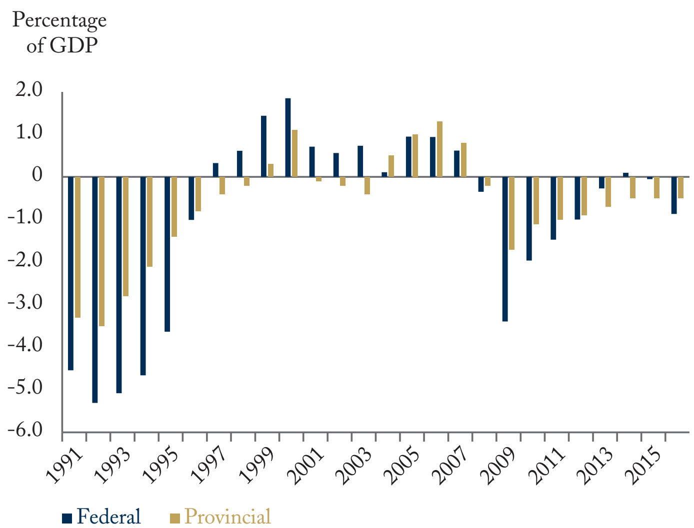
- M1+ (gross*): "Currency outside banks plus personal and non-personal chequable deposits held at chartered banks, trust and mortgage loan companies, credit unions and caisses populaires (excluding deposits of these institutions); plus continuity adjustments (to smooth a time series when there are structural breaks)."
- M1++ (gross): "M1+ (gross) plus non-chequable notice deposits (other than fixed-term deposits) held at chartered banks, trust and mortgage loan companies, credit unions and caisses populaires; less interbank deposits; plus continuity adjustments."

Broad monetary aggregates, again as defined by the Bank, include the following:

- M2 (gross): "Currency outside banks plus bank personal deposits, bank non-personal demand and notice deposits; less interbank deposits; plus continuity adjustments."
- M3 (gross): "M2 (gross) plus bank non-personal term deposits and foreign-currency deposits of residents; less interbank deposits; plus continuity adjustments."
- M2+ (gross): "M2 (gross) plus deposits at trust and mortgage loan companies and at government savings institutions; deposits and shares at credit unions and caisses populaires; life insurance company individual annuities; money market mutual funds; plus continuity adjustments and other adjustments."
- M2++ (gross): "M2+ (gross) plus Canada Savings Bonds and other retail debt instruments; plus non-money market mutual funds."

*Gross is the float, i.e., items in process of collection, not netted.

Figure 1.12: Federal and Provincial Annual Government Budget Balances, 1991–2016



Sources: Canada, Department of Finance, Fiscal Reference Tables; provincial budgets.

Part of the government deficit during the Great Recession can be explained by the fall in tax revenues that accompanies any fall in GDP and by an increase in spending on transfer payments that act as automatic stabilizers during economic downturns. The rest reflected a decision by the federal government to increase discretionary spending to counteract the fall in aggregate demand that threw the Canadian economy into recession. We contend that activist fiscal policy was not important as a stabilization policy tool. Our argument rests on the inherent ineffectiveness of fiscal policy for stabilization policy in a small, open economy such as Canada's, with a flexible exchange rate and a high degree of capital mobility, as shown long ago by Fleming (1962) and Mundell (1963).[10] Also unfortunate is that the deficit that accompanied the increase in discretionary spending to address the crisis, despite getting closer to balance, remained for years after the recession had ended.

The Takeaway

We hope that in this chapter we have established a few things the reader should keep in mind in the journey through this book. First, the period we are looking at is one characterized by three distinct periods: the Great Moderation of 2004–07, the Great Recession of 2008–09 and the sluggish recovery since 2010. Second, monetary policy has played an active and positive role in guiding the Canadian economy through these turbulent times. Third, the sluggish recovery presents an opportunity to think through what changes to monetary policy, if any, would push inflation back to the Bank of Canada's target, which might put the economy on a more positive trajectory.

Finally, we stress that the Great Recession was a shock not only to the world economy, but also to macroeconomic theory. David Laidler, one of our predecessors, sums up changes in the economics profession over the past decade and a half as follows: "[T]he Great Recession came as a shock not just to the world's leading economies, but also to the economics profession. Practitioners of the dismal science had for some years been lulled into a mood of self-congratulation by the stable growth and low inflation seen in the two decades since the Great Moderation" (2017, 252). The Great Recession thus has given macroeconomists an impetus to revise their understanding of how markets work, how shocks are transmitted across economies and how policymakers and central bankers ought to respond.

10 Mao Takongmo (2017) shows that this result continues to hold even when the central bank's instrument is the short-term nominal interest rate rather than the money supply and even when this interest rate is stuck at its lower bound.

Chapter 2

How the Bank of Canada Operates

The Bank's Mandate

To understand better how monetary policy has guided the Canadian economy over the past 14 years, and what the Bank of Canada might do differently as we go forward, it is important first to understand the Bank's mandate and how it operates.

According to the *Bank of Canada Act*, the principal role of the Bank of Canada is "to promote the economic welfare of Canada." The preamble, which has not been amended since the act was passed in 1938, states: "*WHEREAS* it is desirable to establish a central bank in Canada to regulate credit and currency in the best interests of the economic life of the nation, to control and protect the external value of the national monetary unit and to mitigate by its influence fluctuations in the general level of production, trade, prices and employment, so far as may be possible within the scope of monetary action, and generally to promote the economic and financial welfare of Canada." Interestingly, the word "inflation" does not appear at all in the act, while "prices" appears only once, in the preamble. Thus, the exact goals of Canadian monetary policy and the means to achieve them have been refined gradually over time both by the Bank itself and by periodic agreements between the Bank and the federal government. Today, the Bank considers itself as having responsibilities in four main areas:

1 Monetary Policy: The goal of monetary policy is to contribute to solid economic performance and rising living standards for Canadians by keeping inflation low, stable, and predictable.
2 Bank Notes: The Bank of Canada designs and issues bank notes that Canadians can use with the highest confidence.
3 Financial System: The Bank of Canada actively promotes safe, sound, and efficient financial systems, both within Canada and internationally, and conducts transactions in financial markets in support of these objectives.
4 Funds Management: The Bank of Canada provides high-quality, effective, and efficient funds-management and central banking services for the federal government, the Bank, and other clients.[1]

The Bank of Canada's goals and responsibilities concerning monetary policy, the focus of this book, are outlined in detail in its inflation-control agreement with the federal government, which has been renewed every two to five years since 1991 (for the announcement of the latest renewal, see Bank of Canada 2016a).[2] The key objective of Canadian monetary policy is to keep inflation low, stable and predictable. This allows firms and households to make consumption and investment decisions with confidence, domestic and foreign participants are encouraged to undertake longer-term investments and job creation is more sustainable – leading to greater productivity and increases in standards of living. More formally, to maintain stable and low inflation, the Bank of Canada uses its policy rate. As we discuss shortly, the Bank uses a "corridor system," with the overnight policy target rate sitting in

1 Bank of Canada, "Frequently asked Questions: The Bank's Roles," n.d., https://www.bankofcanada.ca/about/educational-resources/faq/.

2 With regard to the financial system, the Bank looks to ensure safe, sound and efficient financial systems both in Canada and abroad, and performs transactions in these financial markets to support this cause. With regard to the currency, the Bank designs, issues and distributes Canada's bank notes to the public. Lastly, with regards to funds management, the Bank acts as "fiscal agent" for the federal government, managing public debt and foreign exchange reserves.

the middle of the rate the Bank charges financial institutions that wish to borrow and the rate financial institutions earn if excess settlement balances are left at the Bank. The Bank generally aims for a small level of settlement balances. Financial institutions demand these balances for a variety of reasons; in Canada, the two primary ones are to make payments to other financial institutions and to include as part of their portfolio of liquid assets. The Bank adjusts the supply of settlement balances through open-market operations (purchases and sales of government securities) to ensure equilibrium of demand and supply at the desired overnight target rate. The Bank sets the overnight target at the level it believes necessary to generate the desired 2 percent inflation target over the medium term. When the Bank changes the overnight rate (and operating band), financial institutions adjust their lending behaviour in such a way that money supply in the economy increases or decreases, since a new loan expands both the asset side of their balance sheets (the loan itself) and the liabilities side (new deposits are created, which are part of the money supply), thereby affecting real incomes and prices.

The Bank of Canada's Balance Sheet

Understanding the major components of the Bank of Canada's balance sheet will help explain the execution of its mandate.[3] The largest single component of the Bank's balance sheet is the issuance of Canadian banknotes on the liabilities side. Canadians consider money in their pocket as an asset, but, as the Canadian economy grows, so does demand for Canadian banknotes, which the Bank considers a liability. For the most part, this liability is supported by Government of Canada bonds and treasury bills,

3 The bulk of this information comes from Bank of Canada (2010b); and Bank of Canada, "Framework for Market Operations and Liquidity Provision," n.d., https://www.bankofcanada.ca/markets/market-operations-liquidity-provision/framework-market-operations-liquidity-provision/.

the two largest components of the assets side of the balance sheet. In general, the Bank purchases a fixed amount of Government of Canada bonds on a non-competitive basis at each bond auction. Treasury bills are also purchased on a non-competitive basis at each auction, but the amounts vary, reflecting the Bank's balance sheet needs. The variation comes from projections of the future demand for banknotes, other liabilities and the value at maturity of upcoming treasury bills and bonds. As well, the Bank performs term repurchase (or "repo") operations: high-quality assets that allow the Bank to conduct operations at longer maturities. More specifically, "the Bank purchases from primary dealers Canadian dollar-denominated marketable securities that are directly issued or explicitly guaranteed by the Government of Canada or by a Canadian provincial government. At the end of the term, the Bank sells these same securities back to the original counterparty at a pre-determined price, with the difference between the Bank's initial purchase and subsequent sale prices equalling the interest for the term of the transaction. The Bank may also conduct term repos for different terms – for example, to offset seasonal fluctuations in the demand for bank notes – and can modify the range of securities eligible if deemed appropriate" (Bank of Canada 2010b). The financial assets on the balance sheet give the Bank a stream of revenue independent of government budgeting, which accords it critical operational independence. The revenue from the assets funds its operations and reserves, and the remaining amounts are sent back to the federal government.

Operational Aspects of the Bank's Monetary Policy

As noted, the Bank of Canada has been an inflation targeter since 1991. To use a term coined by Ben Bernanke (2003), former chairman of the Federal Reserve Board, the Bank operates under "*constrained* discretion." Specifically, the Bank, in its agreement with the federal government, faces a constraint in the form of its 2 percent inflation target. The Bank attempts to hit this target over the medium term – generally six to eight quarters – and in such a way as to minimize variance in output and employment while achieving full-employment output by the end of that period. This buffer period is an acknowledgement that it takes time for monetary policy to affect the real economy and inflation. The Bank's discretion arises from the fact that, despite the target constraint, it can also respond to economic shocks in order to stabilize fluctuations in employment and output. As Svensson (2009, 1) notes: "Flexible inflation targeting means that monetary policy aims at stabilizing both inflation around the inflation target and the real economy, whereas strict inflation targeting aims at stabilizing inflation only, without regard to the stability of the real economy." This means that some weight is put on fluctuations in the real economy, usually defined as fluctuations of GDP around a measure of full-employment output (the output gap). Inflation targeting by the Bank of Canada is similar to that of most central banks in the developed world. Canada, New Zealand and the United Kingdom were all early adopters of inflation targeting, while others, most notably the United States, were slower to formalize a specific rate. For many years, the US Federal Reserve's constraint was to achieve low and stable inflation without publishing an explicit target; in January 2012, however, the Fed announced a formal 2 percent target.[4]

The Bank uses measures of core inflation to focus its attention on the underlying inflation trend. According to the Bank, "[i]n this sense, these core measures of inflation act as an operational guide to help the Bank achieve its total CPI inflation target."[5] The Bank's

4 The US target is 2 percent inflation of personal consumption expenditures, which is not an exact match of the CPI in Canada.

5 Bank of Canada, "Inflation: Measures of Inflation," n.d., http://www.bankofcanada.ca/core-functions/monetary-policy/inflation/.

primary tool for hitting 2 percent inflation is the target for the overnight rate. The Governing Council (consisting of the governor, the senior deputy governor and the four deputy governors) meets eight times a year on predetermined dates ("fixed action dates") and announces its decision on the setting for its key policy rate.[6] In addition to the announcement and accompanying coverage, two of the main publications the Bank uses for communicating with the public are the *Monetary Policy Report* and the *Financial System Review*. The *Monetary Policy Report* is now a quarterly publication – before 2009 it was published twice a year, along with two brief updates – that presents "the Bank's best-case projection for inflation and growth in the Canadian economy, and its assessment of risks."[7] The *Financial System Review* is a semi-annual publication – its first issue was in December 2002 – that provides a detailed investigation into developments in the financial system and the direction of financial sector policy. In the period immediately preceding interest rate announcements, there is a blackout period during which Governing Council members do not give speeches or talk to the media about the economic outlook, the direction of monetary policy or anything considered relevant to the decision. The announcements are published at 10 a.m. Eastern Standard Time on Wednesdays, with the blackout period beginning the prior Wednesday. Decisions of the Governing Council are made by consensus on the day prior to the announcement.[8] The deliberation process itself goes on behind closed doors, with no minutes published for the public to parse.

6 Under extraordinary circumstances, such as during a financial crisis, the Governing Council can meet on dates other than these predetermined dates.

7 Bank of Canada, "Monetary Policy Report," n.d., http://www.bankofcanada.ca/publications/mpr/.

8 Bank of Canada, "Decision-Making Process," n.d., http://www.bankofcanada.ca/core-functions/monetary-policy/decision-making-process/.

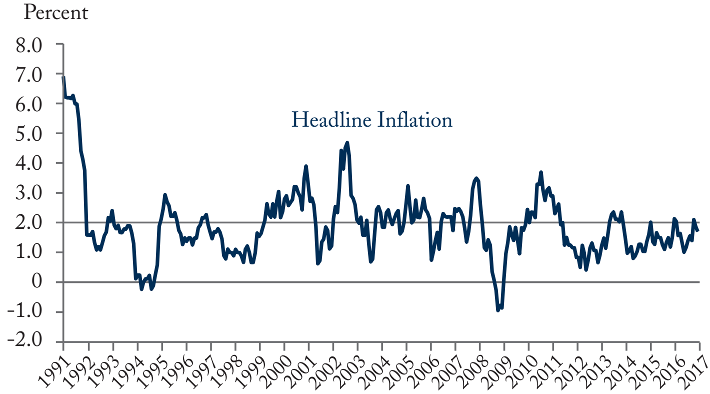
This is in contrast to the US Federal Reserve, whose interest rate decisions are based on votes, and its publishing of minutes helps make explicit the reasons for any lack of unanimity.

Inflation Targeting

With the high inflation that characterized much of the 1980s and the Bank of Canada's not having replaced money growth targeting with a formal policy, then-governor John Crow gave a speech in 1988 in which he stated that price stability would become the primary goal of monetary policy (Crow 1988). The Bank introduced explicit inflation targeting in 1991. At first, the joint inflation-control agreement between the central bank and the federal government was designed to reduce inflation, measured by the year-on-year rate of change of the total CPI, from a rate of almost 7 percent in early 1991 to 2 percent by the end of 1995 (Bank of Canada 1991). Inflation decreased more rapidly than expected, however, and actually became slightly negative in 1994 (Figure 2.1). In a 1993 announcement by the Bank and the federal government, the target rate for inflation beyond 1995 was set to a range of 1–3 percent (Bank of Canada 1993), with the broad goal of maintaining low, stable and predictable inflation over the medium term. Since then, the Bank and the government have renewed essentially the same target in agreements in 1998, 2001, 2006, 2011 and 2016.

In 1991, it was expected that the midpoint of the targeted range would move below 2 percent after 1995. The 1991 announcement stated: "Thereafter the objective would be further reductions in inflation until price stability is achieved. A good deal of work has already been done in Canada on what stability in the broad level of prices means operationally. This work suggests a rate of increase in consumer prices that is clearly below 2 percent. However, a more precise definition is not being specified now, in the event that further evidence and analysis relevant to this matter become

Figure 2.1: Headline Inflation, Canada, 1991–2017



Note: Inflation is year-over-year change at monthly frequency.
Source: Statistics Canada, CANSIM table 326 0020.

available in the next few years" (Bank of Canada 1991). Despite this, the midpoint has remained at 2 percent since 1995. The research agenda leading up to the 2016 agreement did set something of a precedent, however: for the first time since the introduction of inflation targeting, the Bank began examining the possibility of raising the midpoint of the targeted range. We discuss this in detail in Chapter 10.

The Bank adjusts its overnight target rate in a manner consistent with trying to hit its 2 percent inflation target over the medium term – six to eight quarters, the time it is thought to take for monetary policy to work its way through the system – causing other market rates to adjust as well. Accordingly, an eye to the future guides all Bank decisions. In other words, the Bank makes its monetary policy decisions based on where it expects inflation to be in the future, not now. The practice of setting the policy rate to hit the inflation target at a given forecasting horizon is known as "inflation forecast targeting" (see Svensson and Woodford 2004).

The Bank says it views inflation above or below the target as equally troublesome, meaning that its decisions are based on avoiding both high and low inflation (or deflation) with equal fervour. If demand is too strong – meaning the economy is running up against capacity – and raises inflation above 2 percent, the Bank will lift its policy rate. If demand is weak, inflation will ease, and the Bank will respond by decreasing its policy rate to absorb spare capacity, thereby sending inflation back to 2 percent. Whether the concern for deviations from target is truly symmetric, however, is hard to establish for a couple of reasons. First, inflation has been well anchored since inflation targeting began in 1991, and periods in which inflation was significantly away from target have been few. Second, despite remaining within the target band except for brief periods on the down side, inflation has averaged only 1.6 percent since 2012. This has led to extensive discussions about reasons for the undershooting – for example, data measurement issues such as the inaccuracy of shelter costs. Whether discussions would be as widespread if inflation were at 2.5 percent is difficult to say.

In any event, the goal is to keep inflation at 2 percent in the medium term. However, it is not possible for inflation always to sit at that level. Furthermore, the Bank is aware that inflation is not the only economic concern at all times. Economic shocks will push inflation off target in such a way that it is not possible to fight it in the short run, given the delay in monetary policy transmission, without incurring significant volatility in other important macroeconomic variables, including output. Although the Bank will generally aim to get inflation back to target within six to eight quarters, persistent shocks, such as long-lasting increases in oil prices or downturns from financial crises, can make achieving that goal more difficult. In those circumstances, the Bank must judge the appropriate timeline for returning inflation to target in such a way that its actions do not harm financial markets – for example, by stimulating too much household credit – or the economy as a whole.

Discretion thus allows the Bank to adjust the target horizon depending on the type of shock hitting the economy and its expected length. Sacrificing the 2 percent target over the typical two-year horizon is appropriate if it brings the desired longer-term economic and price stability. The ability of the Bank to extend or shorten the horizon as it deems necessary comes from its credibility with the Canadian public – a credibility that has steadily increased since it set the 2 percent target in 1991. In general, this type of credible inflation-targeting policy acts as an automatic stabilizer for the economy. Canada has avoided large business cycle swings of late, including incurring a lesser degree of pain during the recent financial crisis than did the rest of the developed world. Well-anchored inflation expectations allow consumers and businesses alike to take a longer-term view of their financial plans, leading to a more efficient allocation of resources and a more stable economy.

The Welfare Costs of Inflation

The Bank of Canada's mandate to maintain stable and low inflation reflects the idea that inflation imposes economic costs on society. The traditional literature (see, for example, Fischer and Modigliani 1978) highlights the following channels:

1 In an economy in which all contracts and debt instruments (with the possible exception of currency) are indexed to the cost of living, inflation is costly because it reduces individuals' use of money, since higher inflation means a more negative rate of return on holding money balances. Individuals must expend real resources to keep cash balances low and avoid the "inflation tax" – for example, by making more trips to their bank, incurring what economists refer to as "shoe leather costs." In addition, by altering the allocation of

real wealth, inflation might affect capital accumulation and growth. Finally, if the unit of account for transactions is nominal, firms will face the resource costs of changing their prices ("menu costs").

2 In an economy in which the tax system is less than fully indexed, inflation creates distortions by affecting relative real after-tax rates of return.
3 In an economy in which private contracts and debt instruments are not fully indexed, inflation again creates distortions by affecting relative real rates of return.
4 In an economy in which inflation is not perfectly anticipated, shocks to inflation cause expected rates of return to diverge from realized rates of return, and in general affect the distribution of income and wealth among individuals.
5 In an economy with uncertain inflation, inflation changes the risk characteristics of assets and affects the allocation of wealth.

Using the more recent New Keynesian approach to macroeconomics, Ambler (2008) introduces three new channels through which inflation is costly:

1 Different firms set their prices at different times, so there is price dispersion across firms. This leads to changes in demand for these goods that are divorced from their marginal cost of production. If the prices of intermediate inputs that firms use in their production are also rigid, this leads to dispersion in their relative prices and further inefficiencies in the production process (see Ascari, Phaneuf, and Sims 2015). Price dispersion increases at higher rates of trend inflation, and entails greater losses of efficiency in production. The traditional literature discusses the costs of price dispersion in the context of imperfect information that leads consumers to expend resources searching for the cheapest source of goods. In the New Keynesian approach, price dispersion is costly even if buyers have perfect information concerning sellers' prices. If both nominal wages and prices are adjusted infrequently and if wage bargaining takes place at different times for different groups of workers, there will also be wage dispersion across different firms and workers, which is a source of productive inefficiency.

2 Since firms set prices under imperfect competition, their prices are higher than their marginal costs of production. The rate of trend inflation has an effect on the average markup set by firms, and therefore on the size of the distortion due to monopoly power, which constitutes an additional source of inefficiency.
3 At higher levels of trend inflation, firms' pricing decisions are relatively less sensitive to their marginal costs. Monetary policy acts via its effects on aggregate demand, which in turn is related to firms' real marginal costs. Therefore, monetary policy becomes less effective at higher rates of inflation. This leads to a higher variability of inflation at higher rates of inflation, which is also costly.

Why 2 Percent?

A natural question at this point might be: why 2 percent, not some other target? When inflation targeting began, the goal was to reduce inflation from just under 7 percent, given the harm it was doing to the Canadian economy.[9] As it reached its 2 percent target, the next test involved seeing how the Canadian economy would perform over the duration of a business cycle, inclusive of a period in which the economy was at or near potential. By seeing inflation targeting over an entire business cycle, the Bank of Canada would be able to judge whether 2 percent was an appropriate long-run target. As 2 percent inflation appeared correlated with a strong Canadian economy in the intervening years, that target justifiably has remained.

If low inflation is desirable, why not target complete price stability – a target rate of zero? As noted, higher trend inflation is costly because inflation is more variable and unpredictable at higher rates, and firms' pricing decisions become less sensitive to their marginal costs, so that monetary policy becomes less effective.

9 In part, high inflation at this time was due to the introduction of the Good and Services tax (GST).

One important reason for not targeting complete price stability is the so-called zero lower bound constraint on nominal interest rates (see Bank of Canada 2012c). If inflation (and expected inflation) were at zero, the only way to drive real interest rates below zero would be to force nominal rates below zero. Until recently, zero was considered the effective lower bound on central banks' policy interest rates. Some central banks have begun setting their policy rates below zero (as we discuss in more detail below), but there is still a limit on how negative interest rates can go, which depends on the storage and security costs of holding cash. With a target of zero, the Bank of Canada would lose some of its ability to stimulate the economy in times of financial stress. When inflation is positive, however, real interest rates can be negative even when nominal interest rates are at the zero lower bound, and consumers and businesses alike have increased incentives to spend. As we discuss in Chapter 8, a permanent boost to the money supply through quantitative easing is another way to boost inflation without having to resort to negative interest rates.

Another important reason not to target zero inflation is that increases in the true cost of living are difficult to measure. The Bank of Canada (2012c) estimates that the CPI overstates the cost of living by approximately 0.5 percent a year. The implication is, if the Bank targets zero inflation, then in reality it is targeting a deflation, which can be dangerous if it is expected to persist and induces consumers to delay spending.[10]

Lastly, zero inflation means that the only way for real wages to decline is for nominal wages to decline, and there is evidence of a floor on the rate of change in nominal wages. We do not observe

10 Deflation is not always bad. If an economy is doing well and aggregate supply outpaces aggregate demand, we would expect to see an increase in output with prices falling. One must determine the causes of deflation to assess the potential danger.

many nominal wage cuts even in a struggling economy with slack in the labour market (Bank of Canada 2012c). This line of argument contends that workers will accept real wage cuts in downturns via positive inflation, but will not accept cuts in nominal wages. If this is the case, positive inflation is beneficial when real wage cuts are necessary to maintain full employment in the face of downturns in demand.[11]

These three arguments also apply to targets lower than 2 percent, especially if taken together. All three would allow for a target below 2 percent, but the lower one goes the closer one gets to these potential negative consequences.

What about higher inflation targets, which have become a popular suggestion (see, for example, Blanchard et al. 2010) due to concerns over the zero lower bound? One of the main arguments for the higher target is that, in long-run equilibrium, a higher inflation target leads to higher nominal interest rates, which reduces the likelihood of hitting the zero lower bound. This gives a central bank more flexibility to lower interest rates in recessionary periods, in order to stimulate the economy (see Ball 2014a). This becomes even more crucial, as interest rates are likely to be lower on a long-run basis in the future, putting further stress on the zero lower bound (see Côté 2014).[12] Kiley and Roberts (2017), for example, argue in the US context that, given lower long-run interest rates, the federal funds rate could be stuck at the lower bound more than 30 percent of the time.

A higher inflation target, however, would impose costs in addition to those we mention above. One of these costs is the increase in uncertainty and volatility that comes from higher

11 Hogan (1998) looks at the evidence for the existence of downward nominal wage rigidity, and concludes that it is not very strong.

12 Reza and Sarker (2015) discuss the fact that slow growth in the medium to long run means lower neutral rates of interest.

inflation targets and less well-anchored inflation expectations, causing a fall in the effectiveness of monetary policy transmission (Bank of Canada 2012c). The concern is that, if the Bank of Canada can go from, say, 2 to 4 percent with relative ease, little would prevent it from going from 4 to 6 percent. This would harm the Bank's credibility and could turn moderate inflation quickly into high inflation. Additionally, the many contracts negotiated with the 2 percent inflation target in mind likely would need revisiting, creating further disruptions to the economy. Finally, even moderate inflation might be quite costly because relative price distortions affect the use of intermediate inputs as well as final goods (Ascari, Phaneuf, and Sims 2015).

In addition, the Bank can stimulate the economy using more than just the policy rate, including forms of non-traditional tools such as those it used in the Great Recession (we discuss these in detail in Chapter 8). Research continues on unconventional monetary policies, including whether they have caused a loss of central bank independence in those economies where they have been implemented and how central banks should go about exiting them (Côté 2014), yet they represent an additional set of tools that we suggest kept the Great Recession from being even worse.

We argue that, overall, the costs of moving away from the 2 percent target outweigh the benefits, especially if the only benefit is more scope to lower interest rates in bad times.[13] Of course, we could make the same argument for any other rate close to 2 percent, but the merits of a round number for ease of communication make 2 percent more appropriate.

13 As Woodford (2014) points out, however, having a short-run inflation target that moves away from the long-run target is not necessarily counter to being an inflation targeter, but could be necessary in times of stress.

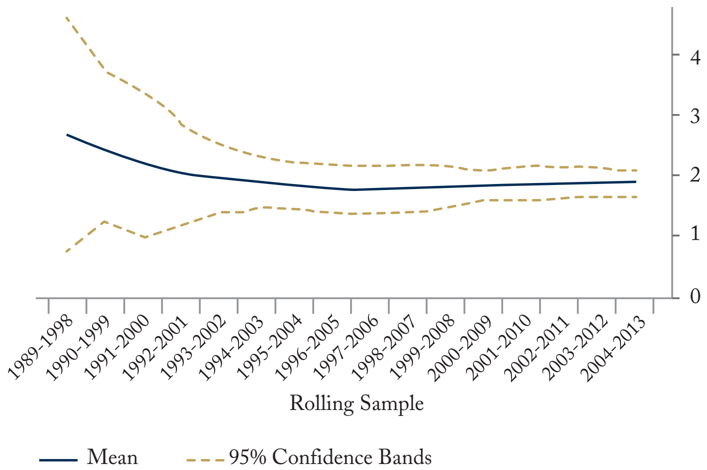
What about Price-Level Targeting?

Another option besides adjusting the inflation target itself would be to turn to price-level targeting. The main benefit of such a target is that it creates even more certainty regarding prices over the medium to long term. This is because, if a price-level target is missed in one quarter under inflation targeting, the quarter is disregarded and the central bank tries to return inflation to the target. Bygones are bygones, and a temporary deviation of inflation from target will have a permanent effect on the price level. With price-level targeting, if an inflation target is missed in one quarter, the central bank undertakes to correct the error and return the price level to a given path. A negative inflation surprise, for example, must lead to inflation that is temporarily above target. For price-level targeting to work best, consumers and firms must be forward looking and understand how the policy works. Credibility is essential. The Bank of Canada, in its research leading up to the 2011 renewal, concluded that, under ordinary circumstances, any benefits arising from price-level targeting are small compared with the risk of leaving the well-understood inflation-targeting regime. In Chapter 10, we discuss how the Bank could improve inflation targeting without necessarily having to go all the way to price-level targeting. This would entail extending the average-inflation targeting period beyond the year-over-year calculation performed today.

What about Canada?

What, then, has been Canada's experience as an explicit inflation targeter? The answer is that it has been quite successful at anchoring inflation expectations (see Figure 2.2). Looking at the average long-run inflation "anchor" for a group of forecasters over rolling ten-year samples, indicated on the horizontal axis of Figure 2.2, we see that forecasters on average expect the Bank of Canada to be able to return inflation to its target within the Bank's forecast

Figure 2.2: Long-Run Inflation Expectations, Canada, 1989–2013



Source: Yetman 2017. Forecast data from Consensus Economics. The panel is made up of 22 forecasters, mostly large financial institutions.

horizon, and that since the mid-1990s there has been very little variance among forecasters. Between 1996 and the beginning of the Great Recession, Canadian inflation averaged almost exactly 2 percent. However, tepid inflation post-crisis does open the door to tinkering with how the objective is achieved and what variables are worth focusing on. We turn to specific suggestions in Chapter 7.

The Transmission of Monetary Policy

With the Bank of Canada's mandate and an understanding of why it seeks to target inflation in mind, we now turn to the transmission of monetary policy, the causal link between changes in the Bank's overnight rate and its ultimate objectives, the inflation rate and the level of economic activity (relative to full capacity). The Bank's own view of the transmission mechanism of monetary policy, as described in one of its *Backgrounders* (Bank of Canada 2012b), emphasizes the effect of its policy instrument, the short-term nominal interest rate, on commercial interest rates, asset prices, the exchange rate, and expectations. That document does not refer at all, however, to monetary aggregates, while the Bank's *Backgrounder* on Canada's money supply (Bank of Canada 2012a) assigns very little importance to monetary aggregates in the transmission of monetary policy, merely noting that monetary aggregates convey useful information to the Bank: "The Bank's economic research indicates that the growth of M1+ provides useful information about the future level of production in the economy. The growth of the broader monetary aggregates is a leading indicator of the rate of inflation."

In this section, through a review of its corridor framework, we analyze how the Bank's policy rate affects economic activity. We also look at the impact of sidelining monetary aggregates on the effectiveness of monetary policy, especially during crisis periods.

Corridor Systems

Many central banks have evolved gradually toward the use of a so-called corridor system (Kahn 2010), in which there is both a floor and a ceiling such that the overnight rate is more tightly controlled. This is the system the Bank of Canada currently uses to set the overnight target rate.

The operation of the corridor system in Canada takes place within the framework of the Large Value Transfer System (LVTS), an electronic funds transfer system that allows major financial institutions to transact with one another via accounts held at the Bank of Canada (Engert, Gravelle, and Howard 2008). The Bank transfers net public payments and receipts within the system to and from the government deposits on its balance sheet in order to affect the net supply of settlement balances related to LVTS participant accounts.

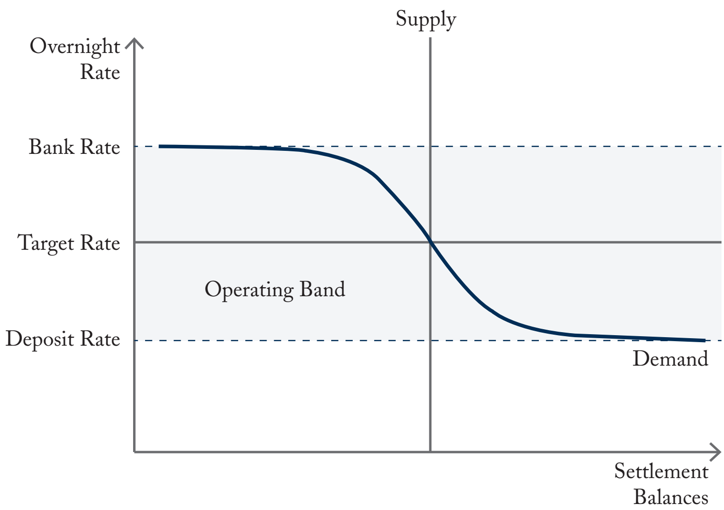
There are three main components to an interest rate corridor system. In Canada, the upper limit, or ceiling, is the interest rate (called the Bank Rate) from the Bank's Standing Lending Facility to LVTS participants. The lower limit, or floor, is the interest rate financial institutions earn on deposits of excess settlement balances left at the Bank (called the Deposit Rate). The spread between these two measures is called the operating band. The target for the overnight interest rate is generally in the middle of this operating band, and represents the third component.[14] The overnight target represents the rate at which financial institutions lend to one another over the course of one day. Significant incentives keep the overnight rate target within the corridor. The fact that surplus settlement balances earn less than the overnight target rate and deficit positions require collateralized loans at the Bank Rate give LVTS participants an incentive to settle within the operating band. Since the opportunity costs of borrowing and depositing are the same at the midpoint of the range, LVTS participants tend to transact at the overnight target rate. Figure 2.3 is a generalized depiction of the interest rate corridor system. The width of the operating band typically has been set at 50 basis points in Canada.[15]

In Figure 2.3, the supply curve is vertical – that is, it is inelastic – as these are the settlement balances provided by the Bank of Canada. In normal times, the Bank will adjust the target rate and maintain the 50 basis point operating band spread, while leaving a small level of settlement balances (Zhang 2012). The demand for

14 For more detail on the corridor system, see Zhang (2012). She notes that financial institutions in the context of the corridor system refer to organizations that have access to central bank liquidity facilities.

15 As Clinton (1997) notes, this spread provides a strong cost incentive for participants to deal in the market, rather than rely on the central bank.

Figure 2.3: The Interest Rate Corridor System



Source: Zhang 2012.

and supply of settlement balances will determine the overnight target rate. The thinking at the Bank on what constitutes a small level has clearly changed over the post-crisis period: at first, $25–50 million was the typical range, but as of December 2017 the level had increased to $500 million.[16] The Bank's rationale for targeting a positive level of settlement balances is to increase liquidity in the system: "This added liquidity helps reduce transaction costs and other frictions during the end-of-day process and, as a result, lessens the need for participants in deficit positions to take frequent small advances from the Bank" (Bank of Canada 2017).

16 In March 2018, the Bank of Canada lowered the target for settlement balances to $250 million.

What about unconventional periods? If the Bank needs to generate a greater change in the demand for settlement balances, or if the zero lower bound is approached, it can make use of the more elastic part of the demand curve, closer to the floor. By expanding the supply of settlement balances, the Bank can drive the overnight rate down to the deposit rate. In order to provide incentives to banks to expand their loans rather than leave balances on deposit at the Bank of Canada, the target rate and deposit rate would have to be lowered in conjunction with this expansion.

From the Target Rate to the Macroeconomy

We have focused to this point on the overnight rate in our discussion of Canadian monetary policy. But in the real world there are many interest rates, including those provided by government securities and corporate bonds. These different interest rates also have different terms to maturity. In normal times, using conventional monetary policy, the Bank of Canada need only target the overnight policy rate in order to generate a simultaneous effect on all rates. Other rates will move depending not only on the overnight rate, but also on market expectations of further changes in the overnight rate and market-determined spreads between different types of assets.

How is this done? Think of this question in terms of an economy that is underperforming, with inflation below target. In such a situation, the bank will lower the overnight target and adjust the Bank rate and the deposit rate accordingly to maintain the 50 basis point operating band. If the Bank reduces the overnight rate, and expectations are that lower rates will remain in place, financial institutions should find it less attractive to continue to lend in this particular market, and will then look to other markets – for example, they will begin purchasing more government bonds, leading to an increase in their prices and a subsequent decline in interest rates. Once interest rates in this market fall, lenders will look for the next more attractive place to do their lending, such as corporate bonds.

Prices for these bonds will increase as demand increases, leading to a fall in interest rates. This pattern continues to occur until all interest rates adjust. This does not mean that all interest rates will fall by the same amount, but in normal times they will all tend to move in the same direction.

In our discussion in Chapter 8 of unconventional monetary policy, we will look at how the transmission mechanism differs in exceptional circumstances, thus influencing the overall effect of monetary policy. As we will show, when short-term interest rates are at their lower bound, increasing inflation expectations via an increase in money balances becomes important.

The Macroeconomy

The Bank of Canada's view of the transmission mechanism is that a fall in interest rates will boost different types of spending directly in an economy as borrowing becomes cheaper. Business spending – for example, on plant and equipment – increases as the cost of funding investment projects declines. On the household side, home ownership becomes more affordable, as does consumption of big-ticket durables such as vehicles, furniture and appliances. Therefore, a decrease in interest rates leads to an increase in both consumption and investment, generating stronger economic growth.

Monetary policy also affects the exchange rate. A fall in interest rates leads to a depreciation of the currency because of a fall in demand for the Canadian dollar. As the currency depreciation takes hold, imports fall as their cost increases, while exports rise as they become more affordable to foreigners. The net effect on the trade balance depends on whether a country is a net importer or net exporter. This mechanism is operative under a floating exchange-rate regime, which was the case in Canada throughout the period we cover. Conventional wisdom holds that it is impossible to have capital freely flowing across a country's borders, a fixed exchange rate and an independent monetary policy. In open-economy macroeconomics, this is known as the "impossible trinity" or "trilemma."[17] If we take as given that it is in Canada's best interest to have free-flowing capital, this imposes a choice between a fixed exchange rate and an independent monetary policy. If an independent monetary policy allows the Bank of Canada to determine the rate of inflation in the short and long run and to stabilize real fluctuations, this supports the case for a floating exchange-rate regime. Former Bank governor Gordon Thiessen (2000) – referring specifically to the bilateral exchange rate with the US dollar, but the argument applies to Canada's interactions with other foreign economies – summarized the argument for floating exchange rates as follows: "The real value of a floating exchange rate for Canada is that it allows us to have different monetary conditions than the United States – monetary conditions appropriate to our own economic circumstances, even as we pursue the same general objective of low and stable inflation. The significance of having this option is our ability to respond to external economic shocks that affect us differently from our southern neighbours, or to respond to differences in domestic economic policies."

With these macroeconomic effects in mind, how does the Bank determine the appropriate interest rate? The transmission mechanism comprises a complex set of economic relationships. What the Bank has to do is determine where the overnight rate should sit in order for the economy to hit the inflation target and operate at potential by the end of a six-to-eight-quarter period. To do this the Bank uses different forecasting and policy analysis models. Many central banks use a version of the Taylor rule (Taylor

17 For a more detailed discussion, see "The Mundell-Fleming Trilemma: Two Out of Three Ain't Bad," *Economist*, August 27, 2016, http://www.economist.com/news/economics-brief/21705672-fixed-exchange-rate-monetary-autonomy-and-free-flow-capital-are-incompatible.

1993) as a rough guide to help determine the required change to the overnight rate target. The Taylor rule specifies that the central bank's policy rate should respond to divergences of inflation from the target and of output (GDP) relative to potential output:

$$i_t = \underline{i} + \phi_\pi \pi_t + \phi_x x_t,$$

where i_t is the overnight rate target, π_t is the inflation rate measured as the deviation from the central bank's target, x_t is the output gap represented by actual less potential (or full-employment output) for the economy and $\underline{i}$ is the long-run neutral interest rate that prevails when inflation is at target and the output gap is zero. The Taylor rule provides a reasonably good description of central bank behaviour over many periods. In addition, it comes close to welfare-maximizing monetary policy in the context of many economic models, including the Bank of Canada's own forecasting model.

ToTEM and BoC-GEM

In December 2005, the Bank of Canada replaced its Quarterly Projection Model (QPM) with the Terms-of-Trade Economic Model (ToTEM) as its primary projection and policy analysis model for evaluating the Canadian economy. ToTEM is an "open-economy, dynamic stochastic general-equilibrium model" that encompasses different production sectors of finished goods and services (Murchison and Rennison 2006, v). These parts of the economy include consumption goods and services, investment goods, goods produced by the public sector and goods produced for export (both commodities and non-commodities). The structure of the Canadian economy forms the basis for the assumptions used to generate this model, crucial for the development of any explanation of what is happening at present in Canada as well as expectations for the future.

Many of ToTEM's features resemble its predecessor. In particular, "a well-defined steady state, an explicit separation of intrinsic and expectational dynamics, an endogenous monetary policy rule, and an emphasis on the economy's supply side" (Murchison and Rennison 2006, v). A key development in the ToTEM model is its ability to allow households and firms to optimize while both in and out of a steady state, in a world where multiple products exist.

In June 2011, the Bank introduced ToTEM II, whose improvements include "(i) multiple interest rates, (ii) sector-specific demand specifications for consumption, housing investment and inventory investment, (iii) a role for financial wealth in household consumption, and (iv) rule-of-thumb price and wage setters" (Dorich et al. 2013, v). In this model, the assumption is that a monetary authority sets the short-term, risk-free interest rate based on an augmented Taylor rule that relies on the output gap, the difference between the inflation target and expected two-quarter-ahead core inflation and an interest rate smoothing term. The equation is thus very similar to the basic Taylor rule described above.

With consumption, the real interest rate is the trade-off between consumption today and consumption tomorrow. When it lowers interest rates, the Bank is attempting to bring consumption forward. Although this policy can be effective, it is offset somewhat by the fact that consumers in general do not like large variations in consumption. Therefore, the effect of monetary policy on consumption tends to be gradual over time. With investment, higher real interest rates mean the cost of expanding a business's capital stock becomes more expensive, reducing profit margins. Therefore, when interest rates increase, there is a reduction in the net present value of any investment spending. Similar to consumption, there is some offsetting of the effect of interest rates due to adjustment costs, which tend to have a greater effect initially. One therefore tends to see a hump-shaped response of investment with respect to changes in interest rates.

In ToTEM, monetary policy affects the level of Canada's exchange rate, which has a direct effect on exports of manufactures and commodities. Imports are affected by the exchange rate change, as well as by changes to final consumption and investment goods. Government expenditures adjust to changes in GDP stemming from net exports to match the share that existed prior to any changes in monetary policy.

Another model the Bank uses is the Bank of Canada Global Economy Model (BoC-GEM), a dynamic, stochastic, general equilibrium model of the world economy. The model has an optimizing representative-agent setup. The model has tradable and non-tradable goods sectors, and distinguishes between oil and non-oil commodities (Lalonde and Muir 2009). The BoC-GEM breaks the world economy into five regional blocs: Canada, the United States, emerging Asia, commodity exporters and remaining countries. The model has many uses, but one is as an input to ToTEM. Like ToTEM, it includes a Taylor rule for each regional economy.

Both ToTEM and BoC-GEM have the feature of monetary neutrality in the long run. That is to say, once prices and wage have time to adjust, monetary policy has no effect on real economic activity.[18] As the Great Depression and other recessionary periods made painfully evident, however, monetary policy can have an effect in the short run, as prices and wages are not fully flexible. ToTEM and BofC-GEM build this feature into the model by embedding short-run nominal wage and price rigidities.

18 Espinosa-Vega (1998) surveys the literature on monetary "super neutrality" – the idea that changes in the long-run or trend rate of inflation can have real effects. Monetary neutrality has to do with the effects of changes in the level of prices for a given trend rate of inflation.

Lack of Money?

As noted, the Bank of Canada's description of the transmission mechanism of monetary policy omits mention of monetary aggregates and money demand. A theme we revisit throughout this book is the fact that monetary aggregates have been underappreciated in the economics profession. Here we offer a brief introduction to the argument on both sides.

Legal reserve requirements for Canadian banks were abolished in 1992, but when they were in force, they required banks to hold a minimum level of deposits with the Bank of Canada that depended on the value of their deposits. By controlling the value of these reserves through open-market operations (purchases and sales of government securities), the Bank could control the amount of deposits created by the banking system, and thereby control the money supply – this is the money multiplier mechanism described in many introductory economics textbooks. With the abolition of reserve requirements, there is no longer an easy or mechanical connection between the size of the Bank's balance sheet and different Canadian monetary aggregates. Additionally, because shifts in the demand for liquidity and money can happen at given levels of interest rates, the link between monetary aggregates and spending is not tight enough for these aggregates themselves to be used as the primary instruments of monetary policy.

The banking system is still responsible, however, for the creation of deposits, which make up a large fraction of the broader monetary aggregates. In normal times, and for given rates of interest on competing assets, individuals will have well-defined preferences for how much of their total portfolio they wish to hold in the form of money and other liquid assets. Changes in interest rates arising from changes in the overnight target rate by the Bank of Canada will affect the demand for liquid assets and broader monetary aggregates. When reductions in interest rates lead to an increased demand for loans and an expansion of lending by banks, new deposits are created that are measured as part of the broad money supply: M2 , M2+ and M2++, as measured by the Bank itself, or M3, as calculated by the Organisation for Economic Co-operation and Development (OECD) based on data provided by the Bank. If households and firms desire to maintain a stable relationship between their holdings of money and their spending (Congdon 2010; Laidler 1987) increases in the broad money supply eventually will lead to increases in spending.

Additionally, other central banks appear to see a stronger relationship between monetary aggregates and the transmission of monetary policy. For example, the Monetary Policy Committee of the Bank of England notes: “In the long run, there is a positive relationship between each monetary aggregate and the general level of prices. Sustained increases in prices cannot occur without accompanying increases in the monetary aggregates. It is in this sense that money is the nominal anchor of the system. In the current policy framework, where the official interest rate is the policy instrument, both the money stock and inflation are jointly caused by other variables” (Bank of England 1999, 11). There is also empirical evidence to suggest there is a very stable long-run correlation between inflation and the rate of growth of narrow and broad money in the United Kingdom and the United States since the nineteenth century (Benati 2009), although the relationship is less stable in the short to medium term. Benati et al. (2016), looking at 32 countries, including Canada, across a hundred-year period, reach similar conclusions about money demand, GDP and interest rates. Specifically, they find a very stable long-run time series and cross-sectional relationship, with the possibility of large and persistent short-term departures.

What can the financial crisis of 2007–08 teach us about the relationship between monetary aggregates and inflation? The financial crisis hit Canada with a lighter touch than it did the

United States – among other things, Canada saw no large financial institution failures. The US experience, however, is instructive in understanding why money demand and monetary aggregates are important. We discuss this issue in detail in the following chapter, but a brief introduction here should help.

Quantitative easing expanded the US Federal Reserve's balance sheet and both the monetary base and broader measures of money. Instead of focusing on monetary aggregates, however, the focus in the United States was on the credit channel. A monetarist would argue that this focus resulted in the permanently lower growth path the United States has been on (Congdon and Hanke 2017; Hanke 2013). Why?

According to the credit channel argument, banks needed to recapitalize. Two things occurred. First, to recapitalize, banks adjusted liabilities by raising new capital or decreasing deposits. The latter reduced the money supply; the former tended to lead investors to exchange deposits for equity, again reducing the money supply. Second, on the asset side, banks began holding more cash or government securities, or reducing lending, once again decreasing deposits and the money supply. We therefore saw an increase in the Fed's balance sheet, which increased money supply, but the credit channel view of the economy offset some of the desired effects. A greater focus on money demand and monetary aggregates might have been more desirable.

Chapter 3

The Macroeconomics of Monetary Policy

So far, we have discussed the evolution of macroeconomic variables in Canada in the years since the last iteration of this book series. We have also reviewed the Bank of Canada's mandate and how the transmission of monetary policy works, at least in theory. In this chapter, we look in more detail at the macroeconomic theory behind the Bank's conduct of monetary policy, with some recommendations for how monetary aggregates might fit in.

Macroeconomic theory explains how macroeconomic variables evolve and interact with one another. Given the number of simultaneous interactions, this task is difficult. The goal for economists involves simplifying reality to concentrate on the relationships that are deemed most important. Macroeconomic theory has undergone major shifts in response to real-world events over the past century. The Great Depression led to the belief that market economies were unstable and that government intervention was required to stabilize them. This was the Keynesian revolution. It was not until the publication of *A Monetary History of the United States*, 1867–1960, by Friedman and Schwartz (1963) that the (negative) contribution of monetary policy to the severity of the depression was generally recognized. This was the monetarist counterrevolution (Johnson 1971). Then, the Great Inflation of the 1970s led central banks to start targeting monetary aggregates to combat inflation. Although inflation was brought under control, the growing instability of money demand during the 1980s in turn led to the undermining of monetarism and the fortuitous experiment in inflation targeting starting in the early 1990s. Whether luck or good policy was responsible for the Great Moderation, it led to increasing confidence in the paradigm of New Keynesian economics.

The Great Recession once again changed the course of macroeconomic thinking and, as a consequence, thinking about monetary policy. One big question seems to be at the forefront: what to do with financial sector variables, and how do they affect monetary policy? Some say that there is not much evidence that flexible inflation targeting needs adjustment in light of the financial crisis of 2007–08: it remains best-practice monetary policy (Svensson 2011). One important lesson, however, is that financial factors can play an important role in the effectiveness of the transmission mechanism of monetary policy. The implication, therefore, is that continued research is needed on how to incorporate financial factors into central bank models. It is possible that theory will evolve so that greater weight is placed on financial variables in the formulation of policy. This does not mean these factors will become targets; it does mean that the financial sector affects the transmission of monetary policy, and policy might have to be adjusted in order to hit inflation and resource-use targets. In the most recent inflation-control agreement between the Bank of Canada and the federal government (2016), the Bank argued that, although it always takes financial system developments into consideration in the formulation of monetary policy, financial stability objectives are best met using financial regulation and supervision that includes appropriate microprudential and macroprudential tools. We discuss this issue in greater detail in Chapter 10.

Despite the changes in macroeconomic theory over the decades, one idea that has been held throughout is that money is neutral in the long run. That is to say, once wages and prices have adjusted, the size of the money stock, no matter how it is measured, cannot affect real variables such as output and employment. Not only do all macroeconomic theories imply long-run monetary neutrality, but the empirical evidence in support is overwhelmingly strong. Of course, this does not mean that inflation (the rate of change of the price level) has no real effects: we summarized the costs of inflation in the previous chapter.

Although money is neutral in the long run, most macroeconomic theories hold that money can have important non-neutralities – that is, influence over real activity and output – in the short run. This means there is a role for monetary policy in stabilizing fluctuations of output and unemployment around their long-run values in response to unforeseen events, even if it cannot affect the long-run values themselves. With this backdrop in mind and with our monetary policy lens, let us focus more closely on the evolution of macroeconomic theory and where it stands now.

Historical Theories

We start with the Keynesian revolution, a major shift in economic thinking heralded by the publication of *The General Theory of Employment, Interest and Money* (Keynes 1936). Classical economics had held that rigidities such as real wage stickiness could slow down an economy's adjustment to a recession, but only temporarily. However, the Great Depression of the 1930s led many to conclude that market economies were fundamentally unstable, that they could potentially remain depressed for a very long time and that government intervention was required to stabilize them. Some versions of Keynesian macroeconomics held that monetary policy was relatively ineffective as a stabilization tool, and that fiscal policy should be the primary tool for stabilization policy, particularly in situations with depressed demand and low interest rates.

Friedman and Schwartz (1963) then argued that monetary policy had contributed to the Great Depression. This "monetarist counter-revolution," in the parlance of Harry Johnson (1971), not only re-established a strong role for monetary policy; it also maintained that monetary policy could cause much harm if not used wisely. Friedman's version of monetarism advocated a constant money supply growth rule for (at least) two reasons. First, monetarism held that the demand for money – and therefore the velocity of the circulation of money – was relatively stable. This had the consequence that steady growth of the money supply, suitably measured, would lead to steady growth in nominal spending. Second, the relative effect of changes in the money supply on prices and real output was subject to uncertain and unpredictable delays. Accordingly, monetary policy could not be relied upon to fine-tune variations in output versus inflation, and the best that could be hoped for was to maintain the growth of nominal income on a steady path, which would be the case if velocity remained steady.

The introduction of the Phillips curve (Phillips 1958) – at the outset an empirical relationship between the rate of change of money wages (and, by extension, inflation) and the rate of unemployment – provided a theory of the determination of the rate of inflation that was missing from Keynesian macroeconomics. Keynesians soon interpreted the Phillips curve as offering a policy trade-off between unemployment and inflation (see, for example, Samuelson and Solow 1960). They recognized that the relationship might not remain stable if it was used as a tool for the conduct of monetary policy, but it contributed to the acceleration of inflation in the 1960s – the start of the period known as the Great Inflation – and to the subsequent breakdown of the fixed exchange rate Bretton Woods system.

In his presidential address to the American Economic Association, Milton Friedman (1968) argued that, if high inflation was used as a tool to lower unemployment, expectations of inflation would increase and, as a result, realized inflation would increase at the given rate of unemployment (see also Phelps 1968). In the long run, when expected inflation adjusts completely to realized inflation, the Phillips curve must be vertical, with unemployment equal to its natural rate and invariant to monetary policy, which can affect only inflation. Friedman predicted simultaneous increases in inflation and unemployment. In fact, the empirical Phillips curve did shift upwards in the 1970s, partly as a consequence of the sharp increase in oil prices in 1973, heralding a period of stagflation, bearing out Friedman's prediction.[1] The supply-driven recessions of the 1970s in Canada and elsewhere brought the supply side of the economy back into focus after the almost exclusive focus of Keynesian economics on aggregate demand.

In addition, the velocity of circulation of money underwent abrupt shifts at the end of the 1960s and during the oil price shock of 1973 and the US recession of 1974. The instability of the Phillips curve and the growing instability of the velocity of the money supply both pointed to the danger of relying on empirical regularities as a foundation for economic theory and policy. This instability lies at the heart of the so-called Lucas (1976) critique. Lucas insisted on the importance of basing macroeconomic theories and policies on relationships that in turn were based on "deep structural parameters" – those of individuals' preferences and those of production technology – so that major changes in policy would not lead to shifts in the macroeconomic relationships used for prediction and policy analysis.

The instability of these relationships (one Keynesian, one monetarist) and the strong influence of the Lucas critique on the academic profession led to the development of dynamic general equilibrium models based on explicit modelling of individuals'

1 See Phelan (2012) for an illustration of the shifts in the US Phillips curve over time.

preferences and firms' technologies, the so-called real business cycle approach to macroeconomics (for a survey, see Stadler 1994). The instability of money demand also led to the undermining of one of the basic tenets of monetarism. For this reason, the first generation of real business cycle models eschewed monetary aggregates entirely – hence the moniker "real" business cycles. In the first generation of real business cycle models, money was neutral not only in the long run, but also in the short run. However, the inability of the real-business-cycle approach to fit the data then led to the blending of real business cycle theory with nominal rigidities, in models where households and firms were constrained to fix prices and wages for extended periods, but could do so optimally to maximize utility or profits. This insistence on an explicit consideration of individuals' maximization problems – known as the micro foundations of macro modelling – was intended to deliver models that were not vulnerable to the Lucas critique.

At the same time, after oil prices again soared in 1979, central banks began to focus on fighting inflation and pursuing stable price policies. When Paul Volcker became chairman of the Federal Reserve Bank in 1979, inflation in the United States was at 9 percent and on its way to 11 percent, where it peaked in early 1980. The Fed did succeed in bringing down inflation to 4 percent by the end of 1983 through a policy of strictly controlling money supply growth, but at the cost of a double-dip recession in 1980 and 1981–82.[2] Despite continued instability in velocity, it was hard to argue that these recessions were due to anything but tight monetary policy.

The introduction of nominal price and/or wage rigidities into the real business cycle framework resulted in a new synthesis, dubbed the new neoclassical synthesis by Goodfriend and King

2 See Goodfriend and King (2005) on the Volcker disinflation. Canada also went through a similar reduction in inflation and a double-dip recession. See Howitt (1986) on the Canadian experience over the same period.

(1997). The pieces of the New Keynesian approach to theory and policy were firmly in place, and the elements were brought together in magisterial fashion in Woodford (2003), which became – for a short time, until the onset of the financial crisis – a standard reference both for macroeconomic theory and for the conduct of monetary policy.[3] New Keynesian economics accepts as a basic premise that prices (and wages) are sticky in the short run. Price stickiness conveys to fiscal policy a role to shift aggregate demand and move the economy toward its long-run potential. It also allows for the importance of monetary policy as a tool to affect both the price level and the real economy, as well as a focus on aggregate supply. Microeconomics plays a more important role in New Keynesian economics than in the monetarist approach or under traditional Keynesian economics.

Money demand instability also led the practitioners of monetary policy to look for an alternative to the control of monetary aggregates to achieve their goal of stabilizing inflation and output fluctuations.[4] They came up with the somewhat fortuitous experiment in inflation targeting, summarized in the previous chapter. Laidler and Robson (2004) document the implementation of inflation targeting in Canada in 1991 and its relative success after an initial adjustment period. This experiment involved the targeting of a short-term nominal interest rate in order to affect longer-term interest rates and aggregate demand directly. The inflation-targeting paradigm as implemented by the Bank of Canada and other central banks since 1992 left no direct role for monetary aggregates. Instead, their

3 Deutsche Bank, which awarded Woodford its Deutsche Bank Prize in Financial Economics, stated that the book "has quickly become the standard reference for monetary theory and analysis among academic economists and their colleagues at central banks." See Center for Financial Studies, "Michael Woodford: the Prize Winner 2007," https://www.ifk-cfs.de/index.php?id=939.

4 As Bank of Canada governor Gerald Bouey famously put it, "[w]e didn't abandon M1, M1 abandoned us!" (Bouey 1983, 12).

role became limited to that of a leading indicator for demand and inflation, and over time even that role has been gradually reduced. In principle, a central bank could target inflation while using money growth as its intermediate target, but this did not become standard practice, and "conventional" monetary policy has come to be thought of as involving the use of a short-term interest rate as the monetary policy instrument. The new neoclassical synthesis reintroduced nominal rigidities, but like the practitioners who adopted inflation targeting, left monetary aggregates out of the picture. Woodford's (2003) treatise came to be known as a treatise on monetary theory without money.[5]

Official inflation targeting – Canada was the second country to adopt inflation targeting, after New Zealand – was associated with milder fluctuations in output and inflation, a period that came to be known as the Great Moderation. We look at this period in Chapter 4, and try to uncover whether the relative mildness of the business cycle during this period was due to good policy or simply to good luck. Whether luck or good policy, however, the Great Moderation led to increasing confidence in the paradigm of New Keynesian economics.

Throughout the entire period, the role of monetary policy and central banks in ensuring financial stability was part of macroeconomics, but there was little integration in macroeconomic theory of the two main roles of central banks: stabilization policy and financial stability. Indeed, as our predecessors (Laidler and Robson 2004, 41) wrote concerning the Bank of Canada's role in supporting financial stability, "[f]or the purpose at hand, what matters is that Canada's approach to these issues in recent years has succeeded to the extent that concerns about macro-financial stability scarcely affected monetary policy in the 1990s." Some of

5 Laidler (2003) refers in his title to "Hamlet without the ghost."

the macroeconomic theory concerning financial stability, such as Minsky's (1986) theory of the credit cycle, was on the periphery of mainstream macroeconomics. Some mainstream theories, though, did begin to look at the financial sector as a source of propagation of shocks (see Bernanke and Blinder 1988; Bernanke and Gertler 1989, 1995). These theories would later play a central role in the new macroeconomic paradigm that developed in response to the financial crisis and the Great Recession.

At the beginning of the period covered by this volume, the New Keynesian approach to macroeconomics represented close to a consensus in the profession. Nominal rigidities slowed the process of adjustment toward long-run equilibrium, but market economies were considered to be essentially stable, and monetary policy could play an active role in speeding up the process of adjustment toward long-run equilibrium. Robert Lucas goes so far as to state: "Macroeconomics was born as a distinct field in the 1940's, as a part of the intellectual response to the Great Depression. The term then referred to the body of knowledge and expertise that we hoped would prevent the recurrence of that economic disaster. My thesis in this lecture is that macroeconomics in this original sense has succeeded: Its central problem of depression prevention has been solved, for all practical purposes, and has in fact been solved for many decades" (2003, 1). Olivier Blanchard, writing a few years later but before the Great Recession took hold in the United States,[6] notes: "For a long while after the explosion of macroeconomics in the 1970s, the field looked like a battlefield. Over time however, largely because facts do not go away, a largely shared vision both of fluctuations and of methodology has emerged. Not everything is fine.

6 The working paper version of Blanchard's article was written in the summer of 2008. Less than two years later, Blanchard was to write a paper on "Rethinking Macroeconomic Policy" with two co-authors (Blanchard, Dell'Ariccia, and Mauro 2010).

Like all revolutions, this one has come with the destruction of some knowledge, and suffers from extremism and herding. None of this deadly however. The state of macro is good" (Blanchard 2009, 209).

Post-recession Theories

The Great Recession, however, turned things on their head. Macro models since that time have kept the focus on micro-foundations to avoid the Lucas critique.[7] Because the recession was precipitated by a major financial crisis in the United States, the functioning of credit markets and their role as a source of, and amplifier of, macroeconomic instability came to the forefront. It also brought back the idea of the fundamental instability of market economies and the need for government intervention to restore stability, both financial and macroeconomic.

The leverage view, pioneered by Fisher (1933) and Minsky (1986), focuses on asset price bubbles and leverage. According to this approach, the Great Recession in some ways was a natural consequence of the Great Moderation, as stable markets led to larger-than-necessary increases in leverage, causing possible destabilization (Brunnermeier and Sannikov 2014). Higher leverage leaves the economy susceptible to small shocks as everyone tries to reduce their leverage when asset prices start to fall. This in turn leads to a fall in consumption, exacerbating the harm from the original fall in asset prices. No balance sheet repairs can be made. No private credit originates with financial institutions, with little demand for it coming from consumers. Much has been, and continues to be, done on this front (see, for example, Bernanke and Gertler 1989; Brunnermeier, Eisenbach, and Sannikov 2013). These models focus on financial accelerators, in which frictions arising from the

7 Sergi (2017, 20) writes that "[a]biding the Lucasian microfoundational program is put forward by [dynamic stochastic general equilibrium] modellers as the very fundamental essence of theoretical progress allowed by consensus."

financial sector create non-linear amplifications of shocks. These models point out the need to focus on credit, asset prices and the non-linear relationship between real and financial variables post–Great Recession.[8]

Some authors have also attempted to bring money more firmly back into the picture (see, for example, Congdon 2014; Hetzel 2009, 2012; Johnson 2011; Sumner 2015). They have argued that, as during the Great Depression of the 1930s, mistakes by the Federal Reserve Bank and other central banks contributed to the onset and the severity of the Great Recession. We concur, and contend that there is evidence to show that monetary policy decisions were at least partially to blame for the Great Recession. (We discuss the causes of the Great Recession in detail in Chapter 5.) Monetarists have been quicker off the mark to argue their case than were Friedman and Schwartz after the Great Depression, but their views are far from the mainstream at the time of writing of this volume: Lo (2012) surveys 21 books about the financial crisis and Great Recession without once mentioning monetary aggregates. In the words of Johnson (2011, 27): "There is little recognition today that tight monetary policy is even an issue, or of the role it had in converting a banking crisis into the 2008–09 Great Recession. It took three decades after the 1929–32 crash until the publication of Friedman and Schwartz's *Monetary History* – for understanding of its monetary causes to reach something like critical mass. One wonders how long it will take this time."

Another big adjustment to modelling since the financial crisis is in the facts used to calibrate and evaluate macroeconomic models. For example, the labour force participation rate in the United

8 It is important to point out that non-linearities do not always survive aggregation, making them difficult to model (for details, see Ng and Wright 2013). But the success of linear models does point out the importance of picking not only the right functional forms, but the correct variables as well.

States peaked in 1999 at 67.2 percent and in 2017 hovers around 63 percent, well below where it was in advance of the financial crisis.[9] Additionally, US real GDP per capita remained lower than its pre-crisis level until the third quarter of 2013, fully six years later. In Canada, the labour force participation rate is also well below its pre-crisis level, and in 2017 sat at 65.8 percent, almost two full percentage points below the pre-crisis peak of 67.7 percent in the first quarter of 2008.[10] Canada's real GDP per capita surpassed its pre-financial crisis peak a little earlier, however, moving ahead by the end of 2011.

Pre-crisis business cycle thinking focused on the variation of macroeconomic variables, while leaving to the sidelines things such as asset prices, financial variables and the financial system as a whole, despite knowing the effect a financial crisis can have on an economy. According to Ng and Wright (2013), one reason for the discarding of financial variables could be that the recessions in the United States in the 1970s and 1980s were in large part supply-and-demand shocks arising from monetary and fiscal policy, and the effect of financial shocks was merely through their amplifying the effects of those supply-and-demand shocks. Both the 1990–91 and 2001 recessions in the United States, however, although milder than the Great Recession, originated in the financial sector – and, of course, financial markets drove the financial crisis itself. As Ng and Wright (2013) show, recessions that start with financial market dislocations differ significantly from recessions in which financial markets play a more secondary role. For one thing, recovery is slower when a recession is in large part due to financial market factors, especially for private credit flows and employment. These differences in reaction to financial sector recessions versus recessions

9 For more data, see United States, Bureau of Labor Statistics, series LNS11300000.

10 Data from Statistics Canada, CANSIM database, table 282-0002. We note that some of this is to be expected with an aging labour force.

arising from other areas of the economy dictate that there were important missing components to both theory and modelling.[11] Through a study of factor models, which analyze co-movements of many different variables expected to have a significant effect on the economy, one finds the importance of financial sector variables to be disproportionate. Ng and Wright (2013), for example, use 132 series, which in turn have their co-movement explained by seven unobservable factors, five of which are financial sector variables. The pervasiveness of these financial sector variables indicates their importance and, as the authors show, there is a significant increase in the variability of these factors during recession years.

On the whole, the consensus on how to interpret the Great Recession in the context of macroeconomic theory is not yet established in its entirety, and this challenge persists for economists. What remains consistent across opinions is the importance of monetary policy both as a tool to stabilize the economy and a potential concern if the Bank of Canada stays near the zero lower-bound constraint. To see this in detail, we turn to a review of the theory underpinning the Bank's monetary policy and a discussion of why monetary aggregates might be underappreciated.

The New Keynesian Underpinnings of the Bank's Conduct of Monetary Policy

The Bank of Canada's operating procedures have evolved gradually over time, to some extent in conjunction with economic theory, in other ways due to practical considerations (see Howitt 2010, 2012). By 2004, the Bank was operating in accordance with the New Keynesian macroeconomic paradigm, which, as noted has its fullest

11 Among other changes noted from US recessions that originated from the financial sector, growth in labour productivity was less pro-cyclical, and there was both an increase in leverage leading up to the recessions and delays in easing access to credit as they began.

embodiment in Woodford (2003). That book's subtitle, *Foundations of a Theory of Monetary Policy*, describes its main goal, while its title, *Interest and Prices*, is an obvious homage to Wicksell (1898), and Woodford refers to his approach as neo-Wicksellian.

Models with nominal price and/or wage rigidities have been used at least since the time of Keynes. The modern tradition of macroeconomic modelling with price rigidities can be traced to Fischer (1977) and Taylor (1979). By the 1990s, the main elements of what has become known as the New Keynesian model were in place.[12] The basic New Keynesian model consists of three main equations, which we summarize in the appendix to this chapter. The first is the New Keynesian Phillips curve, which relates inflation to expected future inflation and to excess tightness or slack in the goods and labour markets proxied by the output gap. The second equation is the New Keynesian investment/saving (IS) curve, which relates the output gap to expectations of the future output gap and to the real interest rate. The third equation is a reaction function for the central bank. The main distinguishing feature of Woodford's neo-Wicksellian approach from New Keynesian models in general is the replacement of the money supply as the main instrument of monetary policy by a short-term interest rate and a complete reduction in emphasis on money demand and monetary aggregates.

The parallels between the way the Bank of Canada operates and Wicksell's (and by extension Woodford's) theory are striking (Clinton 2006b):[13]

1 The main objective of monetary policy is a stable price level. In

12 Rowe (2014) gives a brief summary of the historical development of New Keynesian models.

13 Other authors, such as Fontana (2006) and Laidler (2006), have noted the striking connection between the modern approach to monetary policy by many central banks and modern macroeconomic theory on the one hand, and Wicksell's writings on the other.

modern terms, this translates as low and stable inflation, or a 2 percent inflation target.

2 In Wicksell, the main instrument of monetary policy was commercial banks' interest rates. For the Bank of Canada, it is the target overnight rate.
3 The main means of implementing monetary policy are the central bank's discount rate and deposit rate, exactly equivalent to the Bank of Canada's Bank Rate and Deposit Rate.
4 Monetary policy follows a rule whereby it adjusts its instrument in response to deviations from the objective; the Taylor rule is an example of such a rule.
5 Wicksell thought of a banking system as a pure credit system with no reserves held at the central bank, which has been the case in Canada since 1994 (phased in gradually, starting in 1992) and in many other inflation-targeting countries, although not in the United States.
6 For Wicksell (and Woodford), the main channel for the transmission of monetary policy was the commercial bank rate relative to the neutral or natural bank rate. As noted above, the Bank of Canada thinks of the transmission of monetary policy in terms of the overnight rate (relative to the natural rate) and its effect on commercial interest rates, asset prices, the exchange rate and expectations.
7 Finally, there is an unobservable gap between demand and potential output, which is equivalent to the modern concept of the output gap.

The use of the overnight rate target and the corridor system, and the lack of required reserves, implies that open-market operations to influence the size of the money supply directly are no longer a standard part of the Bank of Canada's tool kit. Longworth (2003) reviews the importance of monetary aggregates from the Bank's point of view, and concludes: "At the Bank of Canada, the monetary aggregates are treated like 'money in the bank': they have value on an ongoing basis and they are often particularly helpful on 'rainy days' (when many other indicators may be failing). Sometimes, however, the balance in their account is somewhat low, so they must be used with particular caution and much judgement" (25).

In 2006, well before the financial crisis hit and led central banks to lower their policy rates to their effective lower bound, David Laidler presciently noted that the possible shortcomings of the New Keynesian or neo-Wicksellian approach was the question of appropriate monetary policy when the central bank's policy rate is at its lower bound:

> In what follows, I shall note that Woodford presents the modern approach to the theory of monetary policy as superseding an older one, which did indeed focus on the interaction of the supply and demand for money, whereas Wicksell, from whom Woodford's analysis draws inspiration, intended his model of the pure credit economy to supplement rather than replace such an approach. I shall then suggest that Woodford's treatment is disconcerting, because monetary economies still pose more problems than can be analyzed by the class of models that he elaborates. I shall illustrate this conclusion by drawing attention to the difficulties that these models encounter when they are applied to certain international monetary issues and also to the so-called "zero lower bound" problem that sometimes arises in depressed economies. (Laidler 2006, 152)

The complete absence of money from the formal analysis used by theoreticians and the Bank's own forecasting models, as well as the fact that the lower-bound problem was thought likely to be rare except during the Great Depression and in Japan during the 1990s, would become problematic during and after the Great Recession, as we argue in Chapters 7 and 8.

What about Monetary Aggregates?

We close this chapter with a broad look at the evidence on the importance of monetary aggregates, since, as we have mentioned, we believe them to be underappreciated in modern central banking. First, we briefly review the main tenets of the monetarist approach.

The central argument of Friedman's monetarism was that changes in the money supply, in a world with constant velocity, will cause an increase in nominal spending and, in the long run, the price level. In simple arithmetic,

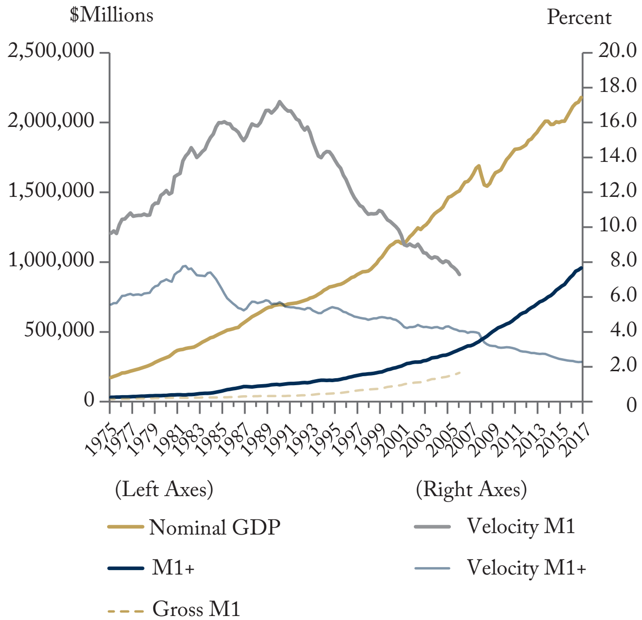
$$MV = PY,$$

where M is money supply, V is velocity, P is the price level and Y is real spending. The central tenets of Friedman's theory are as follows. First, in the short run, money is not neutral: an increase in M leads to an increase in Y because prices and wages are slow to adjust. Second, money is neutral in the long run: an increase in M will affect only the price level; therefore, central banks should not focus on affecting real spending. Third, there is an empirically stable demand function for money that depends on a small number of variables.

The equation above is an accounting identity, and by its very nature must be true. The key to the success of monetarism is the notion that velocity is stable and/or predictable, allowing the money supply to drive nominal spending and prices. Monetarism as a theory received a big boost when Paul Volcker became chairman of the US Federal Reserve in 1979 and succeeded in reducing inflation by reducing the rate of growth of the money supply. The honeymoon, however, took a hit in both Canada and the United States, although it happened earlier south of the border. In the 1980s, the US money supply became dissociated from nominal GDP; in Canada, the velocity of money used for transactions completely reversed course in the mid-1990s (Figure 3.1). The explanation for the breakdown in velocity is similar in both countries, and involves changes to banking rules, financial innovations and, in Canada's case, the abolition of reserve requirements. Let us explore these in more detail.

The definition of money used for transactions is cash in circulation and chequing accounts, commonly referred to as

Figure 3.1: Transactions Balances and Velocity of Money, Quarterly, Canada, 1975–2017



Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0025.

M1.[14] As banks started paying interest on chequing accounts in the 1980s, the distinction between chequing and savings accounts disappeared. Furthermore, the development of money markets, mutual funds and other assets of the kind led to a further shift away from bank deposits. All this caused a change in the types of assets that could be used to carry out transactions, and made monetary aggregates (both narrow and broad) less useful as leading indicators

14 See Box 1 in Chapter 1 for detailed definitions of different monetary aggregates.

of economic activity, affecting the relationship with velocity (Jahan and Papageorgiou 2014). In Canada, we saw this scenario play out in the mid-1990s as technology expanded, around the same time that banks were no longer required to maintain a fixed percentage of reserves with the Bank of Canada (Chan, Djoudad, and Loi 2006).

We note, however, that, despite this breakdown in the predictability of velocity, many continue to argue the merits of monetarism, especially in reference to the Great Recession (see, for example, Christensen 2011; Hetzel 2009), while advancements in monetary theory abound (see, for example, Williamson and Wright 2010). Monetarism is still relevant in the following sense. The quantity theory of money imposes a special role on central banks in that they control the monetary base. It follows that central banks control inflation through their control of money. The importance of inflation derives from the importance of the real interest rate. Monetary policy, therefore, must stabilize expected inflation in order for changes to the policy rate to have a predictable effect on the real interest rate. As Hetzel (2009) points out, it is more than just the real interest rate that matters, but the real interest rate relative to the natural rate of interest, as in Wicksell's theory. This natural rate of interest is the rate of real interest that would prevail at a level of aggregate demand that causes markets to clear when the economy is operating at full potential. Therefore, a central bank that wants to stimulate an economy in the shorter term would have to lower the overnight rate such that the prevailing real interest rate sits below the natural rate of interest. This situation would lead households and business to bring spending forward, thus smoothing output around its long-run trend.

What does this have to do with money? Could it not be argued that this is achievable simply by moving the overnight target and its operating band up and down? The issue, as Hetzel (2009) argues, is that the credit view of monetary policy relies too much on optimistic and pessimistic episodes and the notion that low interest rates are necessarily associated with boom times and high interest rates with recessions. Interest rates on their own do not possess a direct link to inflation. This line of thinking implies the following: First, central banks must have robust procedures for tracking the natural rate of interest. Second, and important for our discussion here, central banks must create and remove money in the system in such a way that inflation is stable and the real interest rate is at the appropriate level relative to the natural rate in order to create aggregate demand that smoothes fluctuations in output.

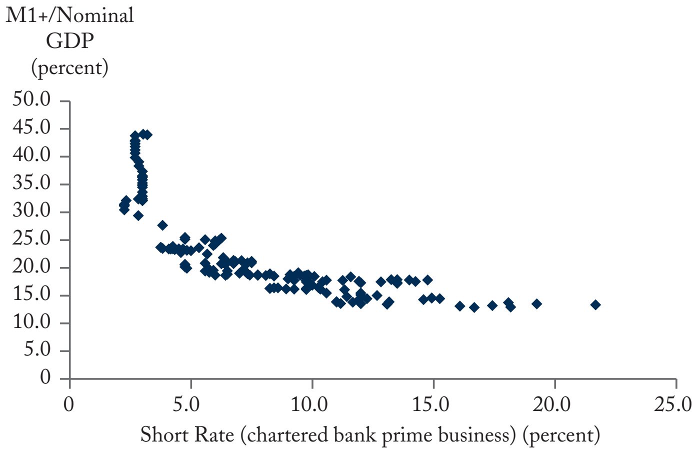
The question we ask, therefore, is whether there is any empirical evidence in Canada that supports the view that monetary aggregates play a significant role in achieving the inflation target. With inflation in Canada stubbornly low and the recovery from the 2007–08 financial crisis slower than most had hoped, it is worth discussing whether a renewed focus on monetary aggregates should be up for consideration. The strength of the empirical evidence on monetary aggregates will tell us the degree to which these variables are underappreciated (or not) at the Bank of Canada.

So, what does the literature say on whether there is a strong link between monetary aggregates and the real economy in Canada?[15] One convincing study, on which we touched earlier, comes from Benati et al. (2016), who show, using a cross-section of 32 countries, including Canada, that there is a very stable long-run relationship between inflation and the growth of money, although with the possibility of large and persistent short-term departures. In Figures 3.2 and 3.3, we loosely replicate their main graphs for Canada.[16]

15 Other countries have continued to find links between monetary aggregates and the economy. In the EU, evidence suggests M1 growth is a leading indicator of turnaround in the business cycle, with broad monetary aggregate growth following the economic cycle closely – although the relationship is less noticeable in downturns (see European Central Bank, Monthly Bulletin, February 2012).

16 The replications are loose in that we did not perform any formal detrending or formal cointegration tests to deal with concerns over unit roots.

Figure 3.2: Short-term Interest Rate versus Ratio of M1+ to Nominal GDP, Canada, 1975:Q2 to 2017:Q4

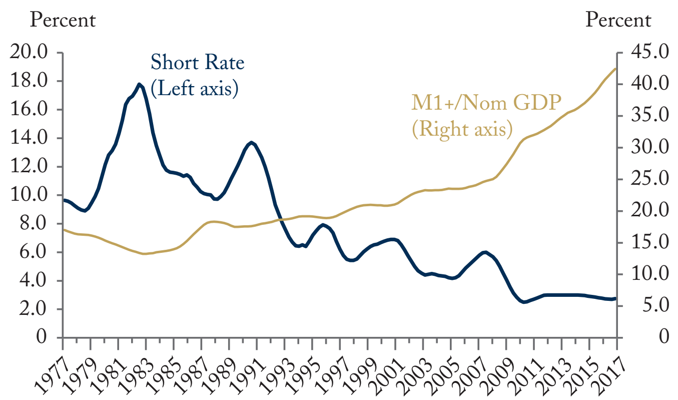


Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0043, 176 0025.

We find strong evidence of the money demand curve predicted by theory (Figure 3.2). As in Benati et al. (2016), in Figure 3.2, we use a short rate – in this case, the chartered Canadian bank prime business rate – on the horizontal axis and nominal M1+/nominal GDP on the vertical axis. As the short rate increases, the demand for money in excess of GDP growth falls. In Figure 3.3, we plot a two-year moving average of both the short rate and nominal M1+/nominal GDP. As expected, they are significantly negatively correlated, which indicates some kind of stable long-run money demand function, reinforcing the link between monetary aggregates and inflation.

Furthermore, Chan, Djoudad, and Loi (2006), in a study of the informational content of different monetary aggregates in Canada, find that, starting in 1995, M1+ became a strong leading

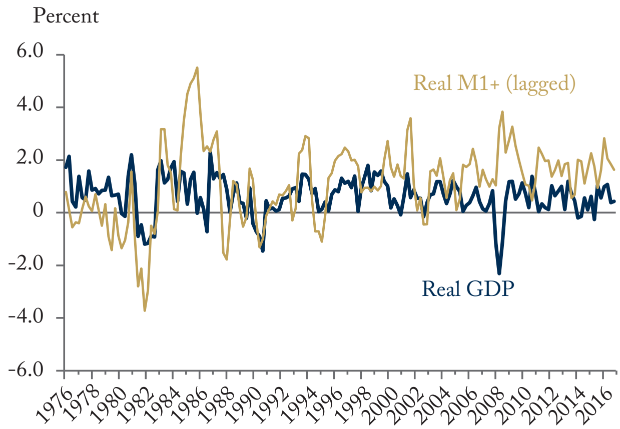
Figure 3.3: Evolution of the Short-term Interest Rate and Ratio of M1+ to Nominal GDP, Quarterly, Canada, 1977–2017



Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0043, 176 0025.

indicator of future output growth. In their paper, as a way of establishing leading property indicators of monetary aggregates, they look at two-quarter moving average real M1+ growth lagged by one quarter, and compare it with real GDP growth – so, for example, they compare second- and third-quarter average growth in real M1+ with fourth-quarter growth in real GDP. This type of analysis provides information on the short-term predictive ability of monetary aggregates. Replicating their results with updated data (Figure 3.4) seems to suggest that real M1+ growth continues to precede real GDP growth, thus acting as a leading indicator. When we run correlation tests, however, the results are somewhat more nuanced. Specifically, we looked at rolling ten-year correlations of one-quarter lagged real M1+ growth versus real GDP growth. What this means is that a data point in, say, the first quarter of 2000 represents the correlation between these two variables from the second quarter of 1991 to the first quarter of 2000. The results

Figure 3.4: Evolution of Real M1+ and Real GDP Growth, Quarterly, Canada, 1976–2017



Note: Real M1+ quarter-over-quarter growth is a two-quarter moving average lagged by one quarter.

Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0025.

show a strong correlation until 2005, before tailing off and even becoming negative during and after the financial crisis (Figure 3.5).

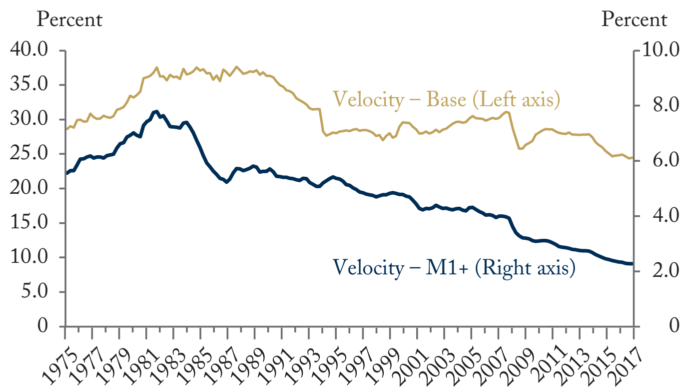
What might explain these falling correlations? One explanation is that a flight to safety occurred during the period of the financial crisis, whereby demand for the more liquid components of money increased. This increased demand has persisted, as can be seen from Figure 3.6, which shows the velocity of both the monetary base and M1+. Although velocity of the monetary base has been stable since the mid-1990s, M1+ velocity began to fall in the early 2000s, and this decrease was exacerbated during and after the crisis. This helps to explain what happened after the crisis, but the fall in correlation levels started before the crisis, around 2005. So what might explain that earlier fall?

Figure 3.5: Rolling Correlation between Quarterly Real M1+ Growth and Real GDP Growth, Canada, 1985–2017

Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0025.

If we allow for an increase in the lag with which growth in real M1+ affects real GDP growth, we can see that the correlations fell just before and during the crisis, but actually rebounded after the crisis. Figure 3.7 shows the relationship for a lag of three quarters. Simple regression analysis confirms that there was a change in the relationship between the quarterly growth of real M1+ and the quarterly growth of real GDP between 1975 and 1995 and again between 1995 and 2015 (see Tables 3.1 and 3.2). For each subsample, quarterly real GDP growth is regressed on its own lag and either the one-lag quarterly growth of real M1+ or the third lag of the quarterly growth of real M1+. For the earlier period, the single lagged growth rate of real M1+ is significant, but not its third lag. For the later period, the reverse is true.

Figure 3.6: M1+ and Base Velocity, Quarterly, Canada, 1975–2017

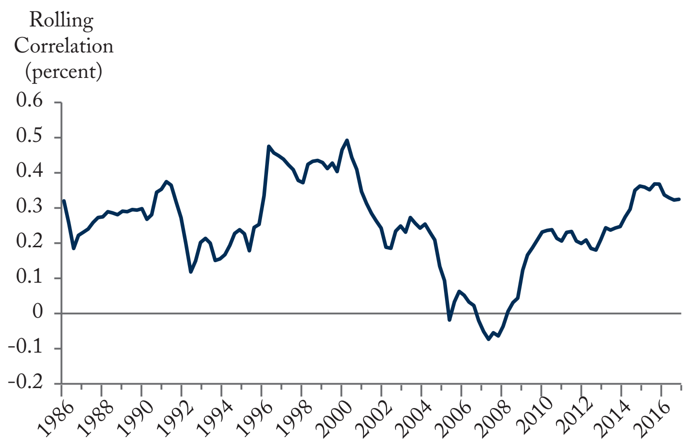


Sources: Authors' calculations; Statistics Canada, CANSIM table 176 0025.

One potential explanation for the increased lag might be the evolution of indebtedness in Canada. Figure 3.8 shows a fairly big spike in the growth rate of the ratio of debt to disposable income in the 2000s leading up to the crisis. It could be that changes in the money supply now have a greater immediate effect on leverage decisions than on spending behaviour. For example, stimulative monetary policy involving an increase in the money supply leads households and businesses to reduce their leverage over the short term and then to increase their spending only after their balance sheets have been sufficiently adjusted.

To summarize, there appears to be a strong long-run money demand function that central banks can use in their monitoring of monetary policy effectiveness. The leading indicator properties of narrow aggregates continue to be true, although consumer behaviour, in terms of both liquidity and leverage decisions, weighs on the reliability of these measures.

Figure 3.7: Rolling Correlation between Quarterly Real M1+ Growth and Real GDP Growth, Canada, 1986–2017



Note: The rolling correlation is shown with a three-quarter lag for real M1+.
Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0025.

Table 3.1: Regression Results, Canada,1975–95

1975–95 (Quarterly)	(1)	(2)
	Δ Real GDP	Δ Real GDP
L.Δ Real GDP	0.392*** (3.22)	0.440*** (3.09)
L.ΔM1+	0.148** (2.57)	
L3.ΔM1+		0.0351 (0.60)
Observations	76	74

t statistics in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculations.

Table 3.2: Regression Results, Canada, 1995–2017

1995–2017 (Quarterly)	(1)	(2)
	Δ Real GDP	Δ Real GDP
L.Δ Real GDP	0.493*** (3.88)	0.484*** (3.73)
L.ΔM1+	-0.006 (-0.09)	
L3.ΔM1+		0.0998* (2.14)
Observations	90	90

t statistics in parentheses.

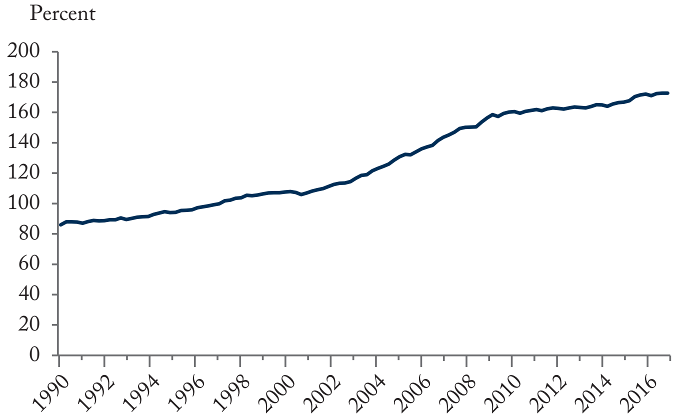
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculations.

What do broader monetary aggregates tell us? Historically, excess money supply – defined as M2++ growth in excess of real GDP growth – and inflation have been strongly correlated over the long run, as Laidler and Robson (2004) find. We have replicated this analysis using more recent data. As Figure 3.9 shows, there was a significant change in the relationship between the broader M2++ and inflation after 2006. Although inflation is firmly anchored in and around 2 percent, excess growth of M2++ spiked significantly during the financial crisis, came back down to pre-crisis levels thereafter, then once again increased during the oil price shock of 2014–15.[17] One possible explanation is that, in a world in which inflation expectations have become well-anchored, moving inflation

17 We also redid the year-over-year results from Bergevin and Laidler (2010) and find a similar pattern. The breakdown also occurred during the financial crisis, with the ten-year correlation exercise confirming this finding.

Figure 3.8: Ratio of Debt to Disposable Income, Quarterly, Canada, 1990–2017



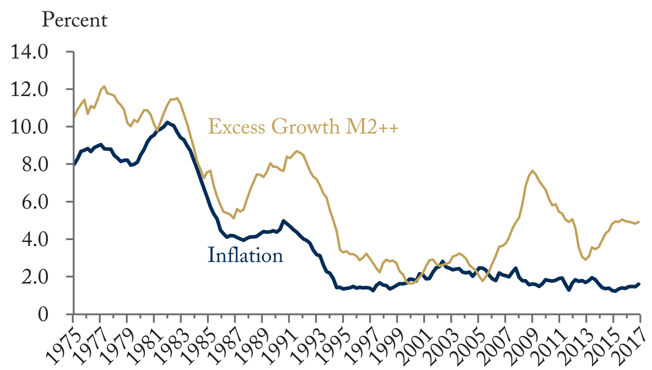
Source: Statistics Canada, CANSIM table 378 0123.

up if it dips below target requires a permanent change in the money supply. Ambler (2016) provides two explanations for why this might be the case in the context of quantitative easing (QE) policies, which, by definition, increase monetary aggregates:

- Price-setting firms know that the price level must eventually revert to its path before QE if the policy is only temporary. Firms do not raise their prices much during QE to avoid being stuck with high relative prices when QE ends.
- A second mechanism is in effect even in the absence of nominal price and wage rigidities. Significant inflation in response to monetary expansion would entail significant deflation when temporary QE ends, entailing high ex ante real interest rates. Consumption smoothing and investment adjustment costs act as a brake on abrupt swings in the ex ante real interest rate.

These arguments also apply in the Canadian case where the expansion in the Bank of Canada's balance sheet was for the

Figure 3.9: Excess Money Growth and Inflation, Quarterly, 1975–2017



Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0025, 326 0020.

purposes of liquidity provision and was understood to be temporary.

One final piece of evidence on broad monetary aggregates is crucial to our view of how the Bank of Canada can use monetary aggregates to implement its inflation target mandate: specifically, the relationship between the growth of credit and broad monetary aggregates such as M2++. The prevailing view of central banks is that moving the overnight rate affects the demand for and supply of credit in such a way as to boost or put the brakes on the economy in order to achieve a specific inflation target. In general, one would assume that credit and broad money growth would track each other closely, as they represent both sides of a typical financial institution's balance sheet. It is possible, however, for excess credit to build up in particular sectors without generating an associated increase in broad money growth and accompanying inflation. When that happens, bubbles occur, as they did during the financial crisis, which can lead to a recession.

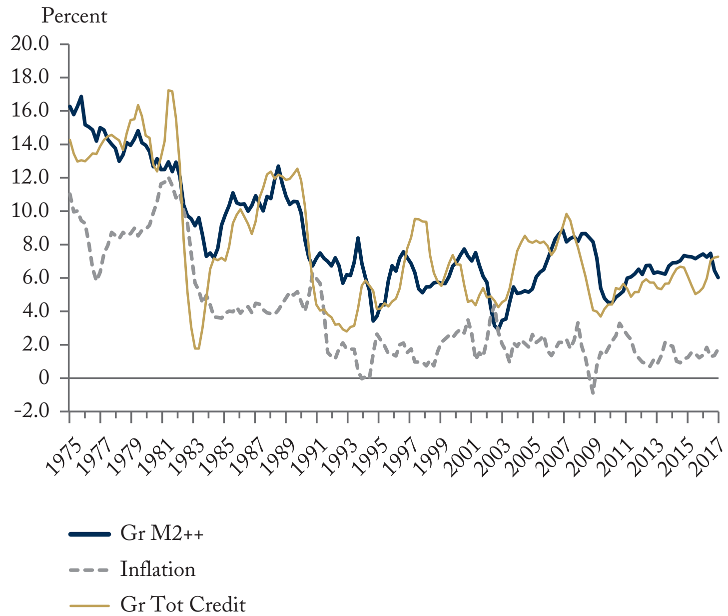
Do we see evidence of any dissociation between credit (total household and business credit) and broad money in Canada? In the past 20 years, two episodes – during the late 1990s and during the years leading up to the 2007–08 financial crisis – stand out in which credit growth decoupled from broad money growth (the difference between the gold and blue lines of Figure 3.10). In both cases, there was no major accompanying change in inflation. In terms of the eventual effect on economic growth, in the case of the early 2000s the dot-com bust followed this credit/broad money dissociation, although the economic effect on Canada was mild, with a drop in real GDP only in the third quarter of 2001. Of course, as Figure 3.11 shows, the financial crisis was marked by a much larger drop in economic activity.

Recommendations

So what does this mean for the Bank of Canada and monetary policy? We believe the evidence we have presented shows that monetary aggregates still have a continuing role to play. Narrow aggregates are still influential leading indicators if we take into consideration the flight to liquidity during the financial crisis and changes to leverage affecting the transmission of monetary policy. Narrow aggregates also seem still to possess long-run money demand features.

Concerning broad monetary aggregates, subject to whether changes to money supply are permanent or not, our policy prescriptions are more nuanced. We start by borrowing a line from Bergevin and Laidler (2011, 1) that summarizes the essence of our suggestion with respect to broad monetary aggregates: "[S]ubject to a continuation of an overriding commitment to a price stability goal, the conceptual framework within which the Bank makes its decisions should be broadened to give an explicit, albeit subsidiary, role to the growth of a broad monetary aggregate." This is a pretty

Figure 3.10: Inflation Rate and Growth of Broad Money and Credit, Quarterly, Canada, 1975–2017

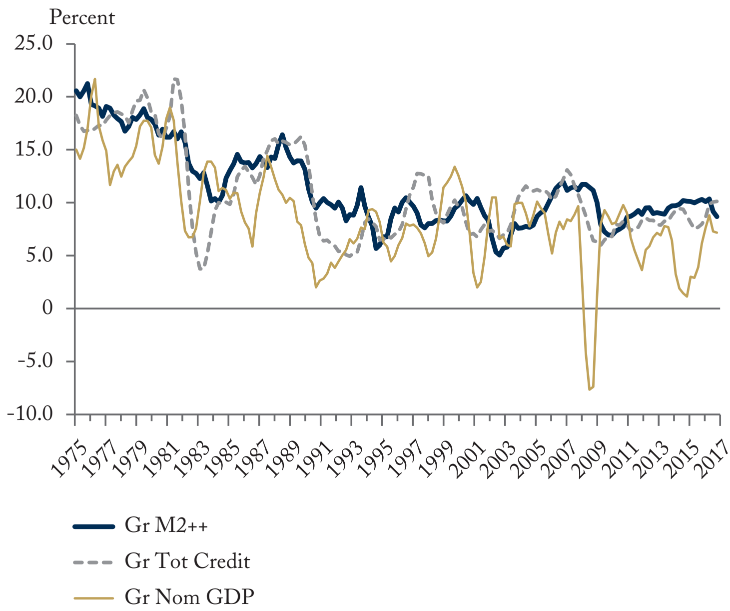


Sources: Authors' calculations; Statistics Canada, CANSIM tables 176 0025, 326 0020, 176 0032.

broad description, so let us drill down on a few specific questions, given the Bank's current monetary policy.

First, we concur with Bergevin and Laidler that an inflation target is a good thing, and we support its continued use in periods of normal and low interest rates. We would add the caveat – on which we elaborate later in the book – that an increase in the period of averaging, or a move to price-level targeting should be considered. An alternative, such as the one suggested by Bernanke (2017), would be to keep the inflation target in normal times, but move to price-level targeting when interest rates are at or near (or below) zero.

Figure 3.11: Growth of Broad Money, Credit and Nominal GDP, Quarterly, Canada, 1975–2017



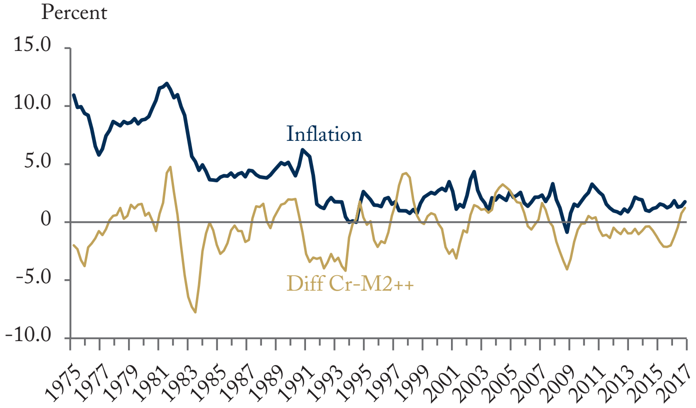
Sources: Authors' calculations; Statistics Canada, CANSIM tables 380 0064, 176 0025, 326 0020, 176 0032.

Furthermore, as we have shown, information is certainly to be gleaned from monetary aggregates, although changing economic behaviour affects their reliability. This means that systematic rules for monetary policy decisions on the overnight rate involving monetary aggregates are unrealistic, but, again borrowing from Bergevin and Laidler, "they nevertheless make it a potentially useful source of supplementary information about longer-term inflation prospects that can be used to cross-check the analysis used in reaching those decisions" (2011, 1).

So, what to target? We find the evidence presented in Figures 3.10 and 3.11 compelling. Specifically, when credit becomes unhinged from broad monetary aggregates, and does not get reflected in price levels, future declines in economic activity are likely. Simultaneous increases in credit growth and broad monetary aggregates, on the other hand, appear much more likely to generate stable inflation. Targeting higher levels of broad monetary aggregate growth might also stimulate (with a lag) higher inflation, as we saw briefly in 2010. The Bank of Canada could publish at some predetermined intervals how these two measures are faring relative to each other and their relationship with inflation. Figure 3.12 provides an example in historical context: levels of credit growth that exceed broad money growth – that is, when the gold line sits above the zero line in Figure 3.12 – and that do not result in significant upward movements in inflation would be cause for concern. The Bank would not need to target any particular broad monetary aggregate, but it could use this differential as a reference for whether current levels of credit relative to money growth are consistent with expected inflation six to eight quarters out. The Bank could continue to use settlement balances and its corridor system in implementing monetary policy. We do not see any credibility issues at play here, as the Bank would continue to target the 2 percent inflation rate. What we propose is simply to create a greater role for the quantity theory of money and less reliance solely on the credit view.

As noted, Canada was fairly unscathed by the financial crisis. In many ways, regulators and the Bank of Canada should be proud of how the financial system and economy fared. Accordingly, we do not propose any big shift here. We do believe, however, that a focus on the relationship between credit and broad money and how differentials contemporaneously affect inflation could play a role in heading off future drops in economic activity, and get us closer to the 2 percent target over the medium term.

Figure 3.12: Credit and Money Growth Differential and Inflation Rate, Quarterly, Canada, 1975–2017



Sources: Authors' calculations; Statistics Canada, CANSIM tables 176 0025, 326 0020, 176 0032.

Appendix 3A: The Basic Three-Equation New Keynesian Model

The main outlines of the standard New Keynesian model can be found in Clarida, Galí, and Gertler (1999); Clinton (2006b); Galí (2008); Goodfriend (2002); Goodfriend and King (1997); Woodford (2003); and Yun (1996). Carlin and Soskice (2005) provide a graphical exposition of the model. The workings of the model in an open economy with flexible exchange rates are described by Ball (1999) and Svensson (2000).

The first equation below is the New Keynesian Phillips curve. It is based on the underlying assumption that firms set their prices optimally when they have the chance to do so, but do not re-optimize their prices every period. This introduces nominal price rigidity, which prevents the economy from attaining its full-employment level of output except in the long run. The equation says that inflation at time t (π_t), measured as a deviation from the central bank's target, depends on expected future inflation, $E_t\pi_{t+1}$, and on the output gap, x_t. β and k are positive parameters, and μ_{1t} is a stochastic shock that affects inflation. It has the interpretation of either a shock to firms' markups over their costs or a productivity shock that affects the costs of production. The equation can be derived from the aggregation of price-setting decisions by firms and from a relationship between the output gap and firms' marginal production costs:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + \mu_{1t}.$$

The second equation is the New Keynesian IS curve, which gives aggregate demand (measured by the output gap) as a function of the future expected output gap and of the real interest rate, which is equal to the nominal interest rate, i_t, minus expected inflation. It can be derived from the aggregation of households' spending decisions. It also depends on a stochastic shock, μ_{2t}, which is a shock to private spending by households or firms:

$$x_t = E_t x_{t+1} + \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1}\right) + \mu_{2t}.$$

The third equation is the Taylor rule, which describes the behaviour of a central bank that sets its policy rate, i_t, as a function of inflation and the output gap, already given above in the main body of the chapter, but to which we add a stochastic shock, μ_{3t}. The Taylor rule is meant to be descriptive, and in fact it fits historical data for many central banks quite well. The rule works to control inflation by moving nominal interest rates and expected inflation to influence economic activity:

$$i_t = \underline{i} + \phi_\pi \pi_t + \phi_x x_t + \mu_{3t}.$$

The Taylor rule is also meant to approximate optimal central bank behaviour, which can be derived by specifying an objective function for the central bank and finding its optimal policy algebraically. The solution to this problem then takes the place of the Taylor rule (for more details, see Clarida, Galí, and Gertler 1999): under certain restrictions, the optimal policy rule takes the form of a Taylor rule. The loss function itself can be derived from the building blocks of the New Keynesian model, as an approximation to the utility function of the representative household. It turns out that, to a second-order approximation, welfare depends (negatively) on the square of the deviations of inflation from its target and on the square of the output gap. We summarized above the costs of inflation in New Keynesian models, but they include price dispersion across firms, which leads to an inefficient allocation of resources and therefore to a level of output that is below full-employment output. As we outline later, since welfare in the New Keynesian model depends on squared deviations of inflation and the square of the output gap, this leads to a second-order trade-off between the volatility of inflation and the volatility of the output gap. A central bank that optimizes its monetary policy in a New Keynesian framework can attain different combinations of inflation and output gap volatility depending on the relative weights it assigns to the two arguments in its objective function.

Note that the Taylor rule gives the policy rate as a linear function of inflation and the output gap. This neglects the fact that the central bank cannot set a policy rate below a certain level, known as the effective lower bound. Before and during the Great Recession, the Bank of Canada judged that the effective lower bound for the target overnight rate was 25 basis points. Since the recovery began, it has envisaged the possibility of a negative target overnight rate – although this has yet to be implemented at the time of writing. The Bank now estimates the effective lower bound to be approximately minus 50 basis points (see Witmer and Yang 2016). This constraint on monetary policy introduces a non-linearity into the linear three-equation model, and has the consequence that the model must have two solutions for the long-run values of inflation and the output gap (see Benhabib, Schmitt-Grohé, and Uribe 2001). One solution has inflation equal to the target and an output gap of zero. The other solution involves the policy rate at its effective lower bound, negative inflation and a negative output gap. We discuss the possible practical implications of this second solution in Chapter 8.

To model an open economy that trades goods and financial assets with the rest of the world, it is necessary to add at least one more equation (to pin down the exchange rate) and to allow the Phillips curve and the IS curve to depend on the real exchange rate. The equation most often used in simple open-economy New

Keynesian models (see, for example, Svensson 2000) is a version of an interest parity condition:

$$i_t - i_t^* = E_t s_{t+1} - s_t + \varphi_t,$$

where i_t^* is the foreign interest rate and s_t is the log of the nominal exchange rate – so that $(E_t s_{t+1} - s_t)$ is the expected rate of exchange-rate depreciation – and φ_t is a time-varying exchange risk premium. Clarida (2009) and Clarida, Galí, and Gertler (2002) show that, in open-economy versions of the basic New Keynesian model, a Taylor rule, with coefficients depending on the structural parameters of the model, is the optimal monetary policy for a central bank that takes the actions of foreign central banks as given. Clarida (2014) shows that, in a simple New Keynesian model of a small open economy, a form of Taylor rule with a time-varying neutral interest rate is the optimal monetary policy when the central bank takes other central banks' policies as given.

Foreign demand shocks can be added to the IS curve, and foreign financial shocks can be added to the interest parity equation (the risk premium term in this equation could be subject to unpredictable fluctuations). An optimal rule for the central bank's monetary policy in principle would mean reacting differently to each type of shock, but the studies cited above show that, in simple models, reacting to a smaller number of observable variables is close to optimal.

The basic model can be extended in many directions. The Bank of Canada's ToTEM model, its workhorse model for forecasting and monetary policy analysis, is an elaborate version of a New Keynesian model. It incorporates nominal wage rigidities as well as price rigidities. It is an open-economy model and, as its name implies, allows for changes in the terms of trade. It breaks down aggregate production into different sectors (commodities versus all other output). It can be used to forecast the evolution of the economy with policy modelled as a version of the Taylor rule, and it can also be used to derive optimal monetary policy when the Taylor rule is replaced by a loss function derived from the utility function of the representative household.

Chapter 4

The Great Moderation and the Taylor Curve

With its framework for the conduct of monetary policy firmly in place, the day-to-day operations of the Bank of Canada between 2004 and 2007 were relatively routine.

In Chapter 1, we documented the decline in volatility of both output and inflation characteristic of the Great Moderation. In the next two chapters, we set the scene for the Great Recession, and address two important questions. First, to what extent can Canada's improved macroeconomic performance during the Great Moderation be attributed to good policy on the part of the Bank of Canada? Second, was the Bank's monetary policy during the first years of the new millennium too expansionary, and did it contribute to the onset of the financial crisis by leading to overinflated real estate and asset prices?

To answer the first question, we look at the Taylor curve: the trade-off between inflation and output variability that can be attained when monetary policy is optimal. To answer the second question, we look at the Taylor rule and what it has to say regarding the optimal level of the Bank of Canada's policy rate in the period leading up to the financial crisis.

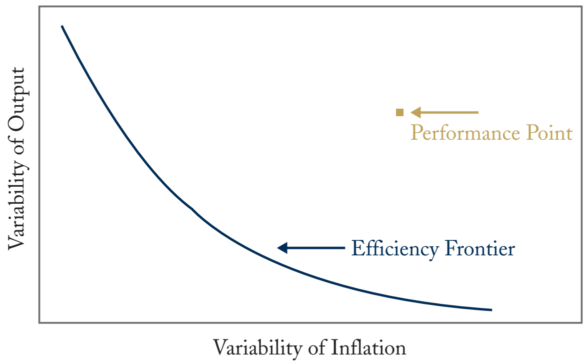
The Taylor Curve

The Phillips curve relationship from the New Keynesian model (see the appendix to the previous chapter) appears to suggest there is a positive trade-off between inflation on the one hand and the output gap on the other. Phillips's (1958) original empirical article showed the striking negative relationship between unemployment and the nominal wage rate in data from the United Kingdom over almost a century, from 1861 to 1957. Given a relatively stable relationship between the rate of change of nominal wages and price inflation and between the unemployment rate and the output gap, the Phillips curve relationship soon came to be interpreted as representing a policy trade-off and choice available to policymakers. In other words, a lower average level of unemployment could be attained at the cost of a higher average inflation rate.[1] The Phillips curve equation from the basic New Keynesian model shows, however, why this trade-off cannot be stable in the long run. The equation says that the relationship between inflation and the output gap is positive only for a given level of inflation expectations. If policymakers attempt to choose a persistently higher output gap – that is, a lower level of unemployment – by allowing inflation to rise persistently, inflation expectations sooner or later will adapt to the new situation. The equation also states that, if inflation expectations are correct and inflation is stable, the output gap must be zero in the absence of shocks to production costs or markups. If the output gap must be zero in the long run, monetary policy does not affect the long-run level of output.

The New Keynesian model, however, implies the existence of another kind of trade-off between inflation and output: a second-order trade-off between the variability of inflation and the variability of the output gap. As noted in the appendix to

1 Chatterjee (2002) gives a good non-technical explanation of the Taylor curve.

Figure 4.1: A Hypothetical Taylor Curve



Source: Cecchetti, Flores-Lagunes, and Krause 2006.

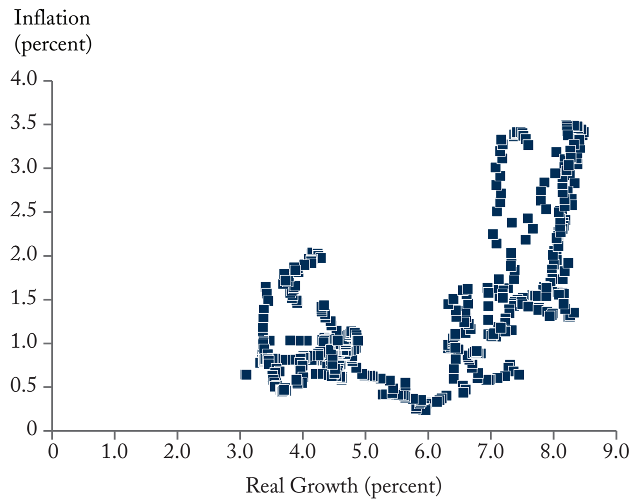
the previous chapter, the New Keynesian model often contains a reaction function such as the Taylor rule for the central bank, which is a fairly accurate description of the historical behaviour of many central banks. The model can also be used to analyze optimal monetary policy. The preferences of households in the model can be used to derive a welfare function that depends negatively on the square of the inflation rate (the current inflation rate and expected future inflation) and the square of the output gap (its current value and expected future values). The relative weights on inflation versus the output gap depend on structural parameters of the model. The model can then be used to derive the setting for the central bank's policy rate that minimizes the welfare losses arising from inflation and deviations of output from its natural level. The optimal policy gives the best attainable variability of inflation and of the output gap, given the structure of the economy and the variability of the shocks that are hitting it.

A higher weight on output variability relative to inflation leads (optimally) to lower output variability and higher inflation variability for the same economic structure and variability of shocks. The relationship between inflation variability and output variability is known as the Taylor curve, first discussed in Taylor (1979). A hypothetical Taylor curve is given in Figure 4.1. The point marked "performance point" on the graph indicates that the actual combination of output and inflation variability that is achieved is to the right and above the Taylor curve. This means that monetary policy has not done as well as it could. If monetary policy is efficient, it can attain a point along the curve.

This trade-off is not directly observable in the data, unlike the Phillips curve relationship between inflation and unemployment (the output gap is also not directly observable and must be estimated). The variability of output and inflation can be calculated, but this involves using rolling moving averages of observations for a particular sample size; calculating variability involves calculating movements relative to a mean, and is not well defined for individual observations. Friedman (2010) calculates ten-year moving averages of the standard deviations of output growth and inflation for the United States, and concludes, counterintuitively, that, "[c]learly, the observed correlation between the variance of unemployment and the variance of inflation is generally positive, not negative" (115). We replicate a similar graph using five-year moving averages, given our shorter sample period, and find similar results (Figure 4.2).

This would seem to contradict the hypothesis of a Taylor curve, which gives a negative trade-off between the variabilities of inflation and output. These moving averages, however, cannot take into account changes in economic structure or the variability of shocks we referred to earlier. One interpretation of Friedman's evidence is that there have been shifts in the Taylor curve over time, as Taylor (2010) notes in his discussion of Friedman's paper. The dates of the observations are missing from Friedman's scatter plot, but US data

Figure 4.2: Five-year Moving Averages of Inflation and Real Output Growth Volatility, Canada, 1970-2017



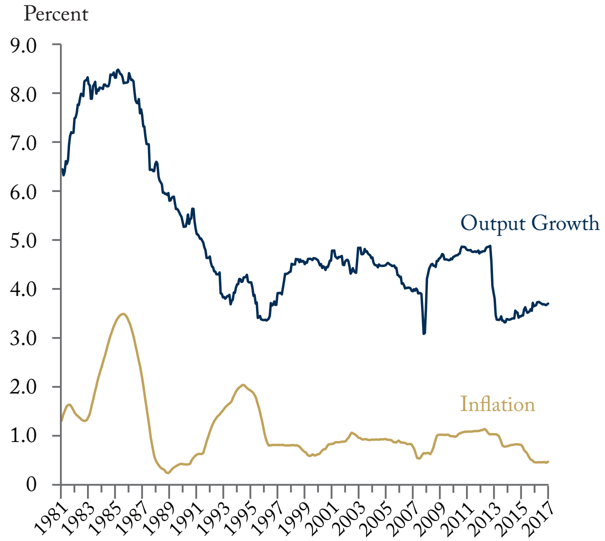
Note: Output growth volatility is defined as the standard deviation of a 5-year moving average of annualized monthly growth; Inflation volatility is the standard deviation of a 5-year moving average of year-over-year monthly inflation.

Sources: Authors' calculations; Statistics Canada, CANSIM tables 379 0031, 326 0022.

clearly show that the volatility of both output growth and inflation came down over time, at least from the beginning of the 1980s until the Great Recession. We replicate and confirm this result for Canada (Figure 4.3). The drop in variability in Figure 4.3 is another illustration of the Great Moderation. Interpreting this drop is even more complicated, however, than just allowing for shifts in the Taylor curve. Bernanke (2004) summarizes three main reasons for changes in the volatility of inflation and output:

1 The volatility of shocks to the economy can change. For example, as is well known, the 1970s were characterized by particularly large fluctuations in the prices of oil and other commodities.
2 The structure of the economy can change. Changes in structure

Figure 4.3: Volatility of Inflation and Real Output Growth, Canada, 1981–2017



Note: Output growth volatility is defined as the standard deviation of a 5-year moving average of annualized monthly growth; Inflation volatility is the standard deviation of a 5-year moving average of year-over-year monthly inflation.

Sources: Authors' calculations; Statistics Canada, CANSIM tables 379 0031 and 326 0022.

could include the increasing importance of services compared to manufacturing, increases in the relative importance of intermediate inputs in production processes, changes in labour market frictions, changes in the frequency of price changes by firms, and so forth.

3 Monetary policy can change. That monetary policy is always optimal in the sense of maximizing welfare in the context of the appropriate New Keynesian model is obviously a very strong assertion.

So it is possible that inflation and output volatility can diminish not because of a shift in the Taylor curve, but because of an improvement in monetary policy that moves the economy closer to the Taylor curve. This is the question of monetary policy efficiency and the degree to which the Great Moderation can be attributed to good monetary policy rather than luck, in the sense of a lower volatility of shocks. A possible measure of monetary policy efficiency is how close it brings an economy to the "ideal" trade-off between inflation and output variability given by points along the Taylor curve.[2] So, what can we say about monetary policy efficiency in Canada during the Great Moderation?

Monetary Policy Efficiency

Cecchetti, Flores-Lagunes, and Krause (2006) study a group of 24 countries, including Canada, and try to apportion the macroeconomic improvements of the Great Moderation to one of two possible sources: either better or more efficient monetary policy or the reduced variability of aggregate supply shocks. To perform this analysis requires a method to determine the allocation of these two explanations to improved macroeconomic performance. One possibility is an inflation and output variability efficiency frontier in which any movement toward the frontier is due to improved monetary policymaking, while shifts in the policy frontier itself reflect a reduction in the variability of aggregate supply shocks. The authors' results indicate that the dominant story is gains in monetary policy efficiency leading to improvements in inflation and output variability (see Box 2).

2 Another possible way to measure monetary policy efficiency is by looking at deviations from the Taylor rule. We have noted that the Taylor rule gives not only a good description of the behaviour of central banks over some periods, but also an approximation of optimal monetary policy. Davig and Leeper (2007) interpret the period of the Great Inflation in the 1970s in the United States as one of important deviations of monetary policy from the Taylor rule. In particular, they note that interest rates responded only weakly to changes in inflation. Unless the nominal interest rate varies more than inflation or expected inflation, the real interest rate varies negatively with the rate of inflation, which can have the effect of magnifying, rather than offsetting, economic shocks.

Box 2: Determining the Source of the Macroeconomic Improvements of the Great Moderation

From Cecchetti, Flores-Lagunes, and Krause (2006), first create an output-inflation efficiency frontier by solving an optimization problem where the central bank minimizes a loss function estimated as a weighted average of the squared deviations of both inflation and output from some assumed target level:

$$Loss = \delta Var(\pi) + (1-\delta) Var(y), 0 \leq \delta \leq 1,$$

where π is inflation, y is output, δ is the policymaker's preference parameter and *Var* represents the variance with respect to some target. We can rewrite this as

$$E[L] = E\left[\delta(\pi_i - \pi^*)^2 + (1-\delta)(y_i - y^*)^2\right],$$

where π^* and y^* are the central bank's targets for inflation and output, respectively.

To break this down further, assume a simple economy that faces two types of shocks that prompt a response from policymakers. The first is an aggregate demand shock in which both inflation and output move in the same direction.* The second is an aggregate supply shock where output and inflation move in opposite directions. In contrast to aggregate demand shocks, aggregate supply shocks force the central bank to make a decision between which of inflation and output variability it wants to offset.

Optimal monetary policy will lead to a combination of inflation and output variability that lies on the curve. Any suboptimal policy will result in a performance point northeast of the frontier. Therefore, as the policy improves, the point will shift closer to the frontier.

* Because of this, in the basic New Keynesian model, it is possible to stabilize the economy completely if there are only demand shocks. This is known in the literature as the "divine coincidence" (see Blanchard and Galí 2007).

Box 2: Continued

With the efficiency frontier established, the next step involves calculating the change in macroeconomic performance for each country in the sample. Cecchetti, Flores-Lagunes, and Krause (2006) do this using a "weighted average of the observed variability of output and inflation." The formal equation for macroeconomic performance is:

$$P_i = \delta Var(\pi_i) + (1-\delta) Var(y_i), 0 \leq \delta \leq 1,$$

where i = 1,2,... represents periods. To get a measure of the change in economic performance between period 1 and period 2, one calculates $\Delta P \equiv P_1 - P_2$, where a positive value is an increase in macroeconomic performance.

The authors then calculate their measure of the variability of aggregate supply shocks as follows:

$$S_i = \delta Var(\pi_i^*) + (1-\delta) Var(y_i^*), 0 \leq \delta \leq 1,$$

where $Var(\pi_i^*)$ and $Var(y_i^*)$ are the variabilities of inflation and output under optimal policy for a particular period. Essentially, if we take the original efficiency frontier, as in Figure 4.1, and shift it out so that the performance point lies on it, we can then trace back the optimal policy on the original frontier that corresponds to this performance point in a particular period.

With these equations in mind, monetary policy efficiency is calculated by looking at the difference between actual and optimal policy performance, or in other words, policy *inefficiency* is as follows:

$$E_i = \delta\left[Var(\pi_i) - Var(\pi_i^*)\right] + (1-\delta)\left[Var(y_i) - Var(y_i^*)\right], 0 \leq \delta \leq 1,$$

so that a positive $\Delta E = E_1 - E_2$ represents a policy *efficiency* improvement between periods 1 and 2. Therefore, the proportion of the improvement in economic performance that is attributable

Box 2: Continued

to improved monetary policy versus changes in the variability of aggregate supply shocks is:

$$Q = \frac{\Delta E}{|\Delta P|}.$$

With the use of an absolute value in the denominator, a positive Q implies increasing policy efficiency, while a negative Q indicates declining policy efficiency.

What do the results in Cecchetti, Flores-Lagunes, and Krause (2006) say for Canada in particular? Canada experienced a macroeconomic performance gain of approximately 50 percent between the earlier part of the sample (from the first quarter of 1983 to the fourth quarter of 1990) and the later period (from the first quarter of 1991 to the fourth quarter of 1998). Of interest is that Canada, in contrast to many of the countries in the sample, experienced an increase in the variability of supply shocks. Therefore the monetary policy efficiency gain was strong enough not only to offset this increase in supply shock variability, but also to generate an improved macroeconomic performance. This is a ringing endorsement of the success of the inflation-targeting framework, at least in the Canadian context.[3]

With empirical results suggesting that monetary policy contributed to the two decades of inflation and output stability

3 Parkin (2016) also discusses the success of central banks, including the Bank of Canada, with inflation-targeting regimes. Fratzscher, Steffen, and Rieth (2018), in a large panel that includes Canada, analyze the success of inflation-targeting central banks as shock absorbers.

that marked the Great Moderation, the natural follow-up question is whether it was also too accommodative, leading to the financial instability that caused the Great Recession.

Too Loose for Too Long?

This is a hotly debated question, and it is worthwhile to present both arguments. What is common to both is the use of deviations from the Taylor rule, and it is here that we start.

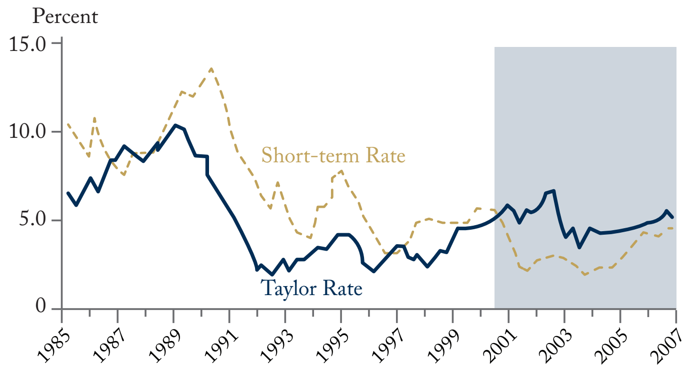
Over time the literature has shown that, even though central banks do not target Taylor rules per se, many have set monetary policy such that they can be fairly well described as using a Taylor rule (see Gerlach and Schnabel 2000; Nelson 2000; Taylor 1993). Perhaps the most common Taylor rule used in the literature, and identical to the one we describe in Chapter 2, is as follows:

$$i_t = \underline{i} + \phi_\pi \pi_t + \phi_x x_t,$$

where i_t is the central bank's policy rate, π_t is the rate of inflation measured as the deviation from the inflation target (2 percent in Canada), x_t is the output gap measured as actual output minus potential output, and i is the long-run neutral interest rate that prevails when inflation is at target and the output gap is zero.

Using quarterly data, Ahrend (2010) calculates, for multiple countries, "below Taylor" episodes, defined as "a cumulated deviation from a Taylor rule of at least 12 percentage points" (2010, 4). For Canada, this calculation led to a persistently "below Taylor" period from 2001 to 2007 (Figure 4.4). Canada was not unique in having a long "below Taylor" stretch, as the United States experienced one from 2001 to 2006, Norway from 2004 to 2007, Denmark from 2001 to 2004 and Australia from 2000 to 2003, as have many

Figure 4.4: Actual Interest Rate versus Taylor Rule Interest Rate, Quarterly, Canada, 1985–2007



Source: Ahrend 2010.

individual eurozone countries – Ahrend calculates that the eurozone itself was only slightly "below Taylor."

Despite these results, there are good reasons central banks deviate from what Taylor rules would prescribe. In the early 2000s, two of the more well-known explanations were the corporate scandals that engulfed many financial services firms and the fear that other developed markets would get swallowed up in the deflationary environment that was wreaking havoc on Japan. Taylor rules struggle to take into account this type of special event, thus providing a justification for lower actual rates.

Although these reasons provided some justification for "below Taylor" rates, other factors argued for tighter monetary policy. Low interest rates prevailed in an environment of financial innovation that led to the expansion of firms' off-balance-sheet positions. This expansion caused monetary policy to lose its position as the dominant creator of liquidity to markets, leading to potential financial instability. Additionally, as has become popular in explaining this period, accommodative monetary policy led to rising asset prices, especially in housing. Whether rates were lowered below Taylor rates or Taylor rates themselves rose to create this gap, the effect of housing on the financial crisis is not in debate. The only difference between the two arguments is that, in the former, central banks are responsible for rising housing prices, while in the latter, central banks do not cause rising housing values but contribute to their continuation by leaving the accommodative conditions in place. Regardless of the explanation, monetary policy below Taylor rules was highly correlated with "housing sector buoyancy."

As we mentioned, Ahrend's results are not without controversy. Choudri and Schembri (2013) reach a very different conclusion concerning the Bank of Canada's monetary policy. They note that the policy interest rate in Canada remained significantly higher than that in the United States between 2002 and 2004, a critical period in the latter country for house price increases. They further note that the interest rate differential between the Bank of Canada and the Fed grew to about 2 percent during this period. They also estimate a Taylor rule for Canada that includes an extra term, the US policy rate, the motivation for which is that the Bank of Canada to some extent can use its policy rate to prevent large movements in the bilateral exchange rate with the US dollar. The Bank's policy rate followed this modified Taylor rule quite closely in the 1990s and in the early years of the twenty-first century. Finally, Choudri and Schembri use a rough measure of expected inflation – core CPI inflation over four quarters as a proxy for expected inflation – for Canada in order to compare real rates of interest between Canada and the United States. Real interest rates fell sharply in both countries in 2001, but remained significantly higher in Canada between 2001 and 2005. The authors argue that looser monetary policy in the United States than in Canada partially explains the relative severity of the 2007–08 financial crisis in the United States. They also argue that differences in monetary policy cannot be a complete explanation, and that differences in the structures of the two countries' financial systems, financial regulations and housing policies also mattered. Given the less severe crisis in Canada, it is hard to argue against their conclusion.

The Productivity Gap

Another way of thinking about deviations of monetary policy from some form of neutral policy stance – in other words, whether monetary policy was too loose or not – is to consider the productivity gap as defined by Selgin, Beckworth, and Bahadir (2015). Using a simple growth model, one can solve as follows to generate the steady-state real neutral rate:

$$r^N = -ln(\beta) + \sigma g + n \cdot$$

This equation says that the real neutral rate of interest is a function of a discount rate β, a risk aversion parameter σ, productivity growth g, and labour input growth n. Of the variables making up this equation, it is productivity growth that has experienced the greatest change of late – at least in the US context – including during the period leading up to the Great Recession. Therefore, productivity growth has been the dominant factor in determining whether the Fed is hitting the neutral rate of interest at a given moment in time. If productivity is growing, as it was during the early 2000s, the neutral rate is increasing, which should be met by actual increases in the policy rate. One can then measure how severe this productivity gap has been by using the following equation:

$$r_t^A - \left(r^N + \sigma g_t\right),$$

where r_t^A is the actual real federal funds rate and $r^N + \sigma g_t$ is the proxy for the neutral rate.

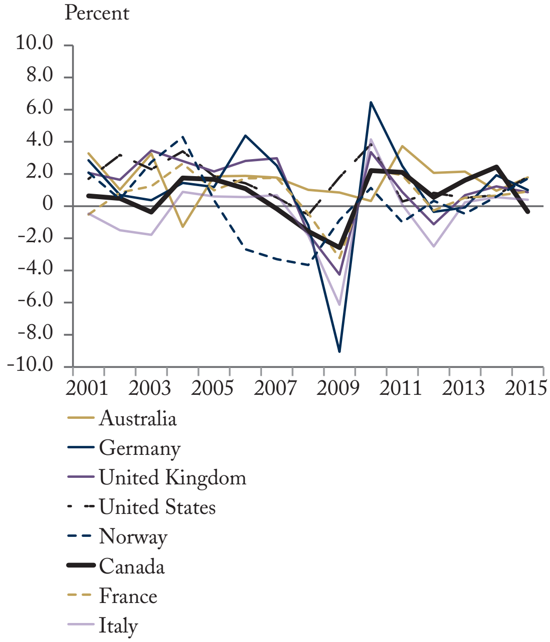
The results for the United States indicate that this productivity gap was negative during the early 2000s, implying monetary policy was too loose. Furthermore, the correlation between the productivity gap and the output gap was negative, as expected, since monetary policy that is too loose is suggestive of actual output in excess of potential. Similarly, durable assets such as housing have an expected negative correlation as well – expected, since looser monetary policy will encourage more borrowing.

Results also show a high correlation between the productivity gap and the gap measured by the Taylor rule. This is not surprising, as the productivity gap directly influences the output gap – a major component of the Taylor rule. Selgin, Beckworth, and Bahadir (2015) argue, however, that productivity gaps take hold earlier in business cycles, and therefore call for earlier reactions by central bankers than for deviations in standard Taylor rules.

Where there are differences between the productivity gap and the Taylor rule, they are caused by the latter's additional incorporation of inflation. Specifically, since productivity growth creates disinflationary effects, a focus on inflation will cause central bankers to lower the policy rate despite a widening of the output gap. With a focus on productivity growth alone, one gets the more desired tightening.

Does Canada fit a similar story? Over the 2000–08 period, Canada was a laggard in productivity growth compared with

Figure 4.5: Productivity Growth, Selected OECD Countries, 2001–15



Source: OECD.

other OECD countries.[4] Although the story has improved for Canada since the financial crisis, this has more to do with slower productivity growth in other OECD countries than with robust domestic improvements (see Figure 4.5). In the lead-up to the crisis, therefore, the productivity gap was not large, meaning that monetary policy in Canada was not overly accommodative as a result.

4 Some of this lag came from Canada's starting at higher productivity levels, but Canada is a middle-of-the-pack country in level terms, so this is not a sufficient explanation.

Although this is a positive result for the Bank of Canada in a historical sense, the low productivity growth story is something that will be key for monetary policy as we look ahead. The results in Selgin, Beckworth, and Bahadir (2015) suggest that the productivity gap needs to be considered as an additional factor in modern versions of the Taylor rule. As we will see in the last two chapters, changes to the neutral rate that are already occurring have important implications for the design of Canada's monetary policy framework.

PART II

Choppy Waters: The Financial Crisis and the Great Recession

Chapter 5

The Great Recession in Canada: The Historical and International Context

The period of the Great Moderation came to an end with the Great Recession of 2007–2009 and its aftermath. What made the Great Recession "Great" was how deep and prolonged it was. It began in the United States in December 2007, and its proximate cause was the financial crisis that began in the summer of that year and deepened in the fall of 2008 with the bankruptcy of the investment bank Lehman Brothers. By the time the Great Recession came to an end, the United States had experienced its deepest and most prolonged downturn since the Great Depression of the 1930s. The recession also struck other industrialized countries severely.

In Canada, the recession began later, in 2008, and was less deep and less prolonged than in its G7 partners, comparable in magnitude to the recessions of 1981–82 and 1990–92. How did the financial crisis happen, how did it affect Canada's financial institutions and how did Canada fare compared to some of its peers?

The Financial Crisis in Canada

In many ways, as noted, in Canada the Great Recession was comparable to less noteworthy downturns in the early 1980s and 1990s, but the domestic effect of the Great Recession and how close it came to being a whole lot worse should not be understated.

A timeline of events should help. Let us start with a review of the situation in Canada in the summer of 2007.

Although the major negative events in the United States occurred in 2008, in some ways Canada's crisis started earlier. For several years, asset-backed commercial paper (ABCP) had been a hot short-term investment. ABCP is a short-term instrument used by an asset-backed commercial paper program – or "conduit," typically sponsored by a financial institution – to finance the purchase of longer-term assets that could include residential mortgage-backed securities, collateralized bond obligations, auto loans, student loans, credit card securitizations and bank and corporate bonds. The return to investors investing in ABCP is the spread between this form of commercial paper and other forms of short-term commercial paper. Traditional financial institutions use ABCP primarily as a way to raise money to fund short-term obligations, critical since the maturity of their liabilities, such as demand deposits, is typically much shorter than that of their assets.

The development of the non-bank ABCP market in Canada accelerated in 1998 when Coventree Capital, a relatively unknown firm, began financing the purchases of US mortgage-backed securities by issuing short-term debt (Lavoie and Seccareccia 2012). Other financial institutions soon followed suit, and by the end of 2006 the market had reached over $117 billion in size, of which almost half was held by non-banks (Chant 2009, 20). As the US subprime market began to signal trouble, buyers for non-bank ABCP dried up, and those who held any were unable to cash in. The market for ABCP froze: approximately $32 billion of ABCP, about a quarter of the total market, could not be refinanced.

In response, a group of note-holders called the Pan Canadian Investors Committee determined to buy up non-bank ABCP and convert it into longer-term bonds. The process was anything but smooth, as the banks that provided the derivatives making up the non-bank ABCP wanted significantly more collateral in order to accept the deal. Negotiations dragged on through 2007, and a final settlement was not reached until early 2009, under the leadership of new Bank of Canada governor Mark Carney. Under the agreement, the foreign banks that were making the bulk of the demands settled for just over $4 billion in loan guarantees from the federal and provincial governments (Greenwood 2013).

During the rest of 2007, the Bank used its traditional tools to reinforce the overnight rate target in order to provide liquidity to financial markets. That is to say, it used "transactions with a limited set of counterparties on the basis of the most liquid, high-quality securities" (Zorn, Wilkins, and Engert 2009, 5). The Bank's Standing Liquidity Facility, which provides collateralized overnight loans to direct participants in the system that are experiencing temporary shortfalls in their settlement balances, continued to be available to address any such shortfalls in Canada's Large Value Transfer System (the LVTS, discussed in Chapter 2 above in the section on corridor systems).

As the end of 2007 neared, the Canadian Imperial Bank of Commerce announced it was more exposed to the US subprime mortgage market than market participants previously believed. The bank, to its credit, decided in early 2008 that it would be prudent to raise not just the minimum equity to placate markets, but to raise it enough to deal with potentially rare but extreme events. With the public confident that Ottawa would not allow a large Canadian financial institution to fail, investors flocked to the equity issuance at a price well below its pre-subprime exposure price. So, in the end, private equity capital came in and saved a situation that threatened, however remote the possibility, the viability of a large financial institution.

In 2008, the failure of Lehman Brothers triggered global panic as investors realized that, if the US government would allow Lehman to fall, no one was safe. In the fall, the US government unveiled the Troubled Asset Relief Program (TARP), a plan to provide capital to financial institutions by buying their toxic assets. Although Congress initially turned the plan down – triggering a plunge in the stock market – the bill eventually passed.

On the fiscal front, Canada took a different approach, but with the same goal of boosting the economy, telling Canada Mortgage and Housing Corporation (CMHC), for example, to buy up to $25 billion worth of mortgages from the banks with the goal of providing them liquidity so they could keep lending to households and businesses.

For the Bank of Canada, however, it was clear that existing liquidity facilities were insufficient to allow it to deal with growing market-wide concerns, since these facilities were only overnight in length or targeted at a specific financial institution. This is an important issue, as liquidity problems that only one institution faces have different economic effects – and therefore require different facilities – than systemic liquidity problems. In response – and similar to measures taken by central banks in the United States and the United Kingdom – the Bank introduced many different forms of facilities to ensure a liquid financial market, to keep credit markets working and to prevent any drying up of funding that would further slow the economy. Beginning in late 2007, the Bank increased the amount of longer-term liquidity available to financial markets by introducing the Term Purchase and Resale Agreement (PRA) Facility (discussed in more detail in Chapter 6) to provide liquidity to support the efficient functioning of financial markets. In April 2009, this facility was modified to reinforce the Bank's view of the future path of the overnight target rate. Eligible counterparties included primary dealers, who were the usual counterparties in

Table 5.1: Peak Emergency Liquidity Facility Usage, Canada

	Nominal Peak	Quarter It Occurred	Peak as Percent of Real GDP
	($ Billions)		
Term Purchase and Resale Agreement	37.00	2008/Q4	2.34
Term Purchase and Resale Agreement – Private Sector	3.26	2009/Q2	0.21
Term Purchase and Resale Agreement – Money Market	0.85	2009/Q1	0.06
Term Loan Facility	4.18	2008/Q4	0.26

Source: Kronick 2016c, Table 2.

repos, and a broad range of securities.[1] The Term PRA was by far the largest facility used during the crisis (see Table 5.1).

As the crisis continued, however, the mechanisms that supported the usual counterparties proved inadequate, as these recipients were unable or unwilling to lend to businesses and/or households. In response, the Bank first allowed institutions to substitute less-liquid assets for more-liquid ones. The Bank also offered LVTS members a limited time in which to exchange their non-mortgage loan portfolios for more marketable securities, which could then be used as collateral in funding markets. The Bank also introduced

1 Lavoie, Sebastian, and Traclet (2011, figure 1) compare the provision of liquidity by the Bank of Canada and the US Federal Reserve and determine that the Fed's liquidity provision had shrunk almost to zero by the end of 2009, meaning that most of the vast expansion of the Fed's balance sheet after 2009 did not fall into this category.

the Term Loan Facility, allowing direct participants in the LVTS to secure term loans against their non-mortgage loan portfolios. Furthermore, the Bank introduced the Term PRA Facility for private sector money market instruments, and later the Term PRA Facility for private sector instruments. The goal of these facilities was to reinforce a liquidity backstop for large institutions operating in both the Canadian money market and corporate bond market that were regulated either federally or provincially and not eligible for the regular Term PRA – that is, to be eligible, they could not be Canadian primary dealers in Government of Canada securities or direct participants in the LVTS. A broad range of securities was eligible and subject to certain credit and other criteria. Non-primary dealers were able to participate indirectly, meaning they had to submit bids through a primary dealer.

By 2010, the Bank had wound down many of the extraordinary liquidity facilities put in place during the crisis. It indicated, however, that it would reintroduce them at its discretion if financial sector stresses were sufficiently deep and broad. The Bank also reserved the right to allow access to the recently introduced discretionary Contingent Term Repo Facility, another longer-term emergency facility (*Monetary Policy Report*, January 2015; see also Longworth 2010). Throughout the crisis, the Bank was aware of the potential dangers of intervening in financial markets to support individual companies. According to Zorn, Wilkins, and Engert (2009), the Bank based its provision of extraordinary liquidity on the following five principles:

- intervention should target distortions of system-wide importance;
- intervention should be graduated, commensurate with the severity of the problem;
- the means of intervention should be well designed, using tools appropriate for the problem;
- intervention should be efficient and non-distortionary; and
- measures should be taken to mitigate moral hazard.

Compared to the Fed, the Bank of Canada's intervention to support financial markets was limited in scope and duration, although proportional to the severity of the situation. The Fed's balance sheet expanded proportionally much more, and brought a wider range of assets onto its books. As a result, many have criticized the Fed for distorting credit markets and lending decisions by the private sector (see Bordo 2008; Cochrane 2009, 2012; Hummel 2011). Hummel writes:

> With this barrage of sometimes seemingly incremental steps when viewed individually, an amped-up Fed was bailing out such firms as Bear Stearns and AIG, assisting the Treasury with its TARP subventions, lending extensively to a new array of institutions including investment banks and money-market funds, and purchasing large amounts of such new financial instruments as commercial paper and mortgage-backed securities. More than half of that activity was financed not by issuing true base money, but by directly or indirectly borrowing from the private sector in one way or another. In this way, phase two of Bernanke's policies transformed the Federal Reserve from a central bank confined primarily to managing the money supply into an institution that is also a giant, government intermediary that borrows large sums in order to allocate credit. In that respect, it has become similar to Fannie or Freddie, with the important distinction that the Fed has greater discretion in subsidizing a wider variety of assets. (2011, 509.)

In contrast, the Bank of Canada faced a much smaller crisis in financial markets, and was much more careful to use market mechanisms to allocate liquidity to financial institutions As Zorn, Wilkins, and Engert (2009, 11) write: "The liquidity facilities introduced by the Bank were designed to minimize the risk of market distortion. The facilities use an auction mechanism to allocate liquidity so that the price of liquidity is determined competitively by the participants, rather than by the Bank of Canada … In addition, the facilities were designed to preserve the existing market structures. For example, in the Term PRA Facility for private sector instruments, bidding by private sector market participants was done through primary dealers, which reduced the risk that the Bank of Canada would crowd out traditional market-makers." It can be argued that the Bank was much more conscious of the dangers associated with its role as lender of last resort – thus creating both the expectation of bailouts and the moral hazard associated with such expectations – than its counterparts in other countries. We largely agree with the approach the Bank took from a liquidity perspective, although in Chapter 11 we suggest some ways to improve the use of emergency liquidity facilities.

Financial Institutions in Canada

This short summary of Canada's experience of the financial crisis would be incomplete without acknowledging the role the country's financial regulatory structure had in ensuring that the crisis never became systemic here, without any bank or other financial institution failures and with profits at Canada's major chartered banks actually continuing in the black.[2] As discussed earlier, there is controversy over whether the relatively minor character of the crisis in Canada can be explained by institutional features, good policy or good luck. Although there is no doubt that luck played a role, there is a strong case to be made that the regulation and structure of the Canadian banking system helped Canada escape the worst consequences of the crisis (see Booth 2009; Bordo, Redish, and Rockoff 2011; Calomiris and Haber 2014; Haltom 2013; Knight 2012; Ratnovski and Huang 2009). We summarize some of the evidence supporting this view.

Ratnovski and Huang (2009) compare the pre-crisis fundamentals of Canadian banks with their OECD peers. They

2 "The Charms of Canada," *Economist*, May 6, 2010, https://www.economist.com/node/16059938/print.

first look at balance-sheet fundamentals. Canadian banks were generally in the third-from-highest quartile in terms of capital ratios, which the authors show to be good predictors of financial distress: of the twelve banks with the worst capital ratios in their sample, six lost more than 85 percent of their equity value and four others between 70 percent and 85 percent during the crisis. Of the twelve, five required government intervention due to extreme stress and five others due to other weakness. They judge that Canadian banks had high enough capital ratios to "avoid insolvency problems on minor losses" (7). In terms of liquidity, measured as the ratio of liquid assets to total debt liabilities, Canadian banks were in the second quartile of the OECD sample, which likely contributed to their resilience. Looking at funding structure, which measures the relative use of deposits versus wholesale markets (such as interbank loans),[3] Ratnovski and Huang find that Canadian banks most of which were in the top quartile of their sample, were well placed to weather the crisis, noting: "One likely reason for Canadian banks' firm grip of deposit supply is their ability to provide one-stop service in mutual funds and asset management" (12). The authors' balance-sheet measures do not measure directly the exposure of Canadian banks to troubled US assets, but they note that this was quite limited for Canadian banks, perhaps because of Canada's strong regulatory environment. Additionally, the size of shadow banking activities amounted to about 40 percent of the Canadian economy as opposed to 95 percent in the United States (Gravelle, Grieder, and Lavoie 2013). After barriers between brokerage and banking activities were removed in 1987, Canadian banks absorbed brokerage and lending activities that occur outside the traditional banking sector in the United States. It is also possible that the

3 Reliance on wholesale markets exposes banks to rollover risks, a new kind of bank run that takes place when banks suddenly refuse to lend short-term funds to each other, as opposed to a classic bank run when retail clients suddenly try to withdraw their deposits (see Gorton 2009 for a discussion).

greater degree of diversification of Canadian banks' loan portfolios stemmed the development of securitization. In the United States, banks developed the originate-and-distribute model, which allowed them to reduce their regional exposure. Canadian banks were less leveraged than their American counterparts, and relied more on their deposit base than on the interbank market for their short-term financing (Booth 2009).

The Great Recession in Canada in Historical Context

We have referred to the fact that the Great Recession was less severe in Canada than elsewhere. To this point, however, we have not presented many broad macroeconomic aggregates to support this view, nor have we looked at how the recession compared with previous recessions in Canada.

Cross and Bergevin (2012) provide data on Canadian recessions going back to 1926. Their study, part of the C.D. Howe Institute's Business Cycle Council, can be taken as the definitive source for the dating of business cycle turning points in Canada. They also categorize Canadian recessions since the 1920s according to five major types, with 1 being the least severe and 5 being the most; according to this classification, Canada has experienced twelve recessions over the past century: two were category 5, associated with the Great Depression that began in 1929. In contrast, Cross and Bergevin rate the 2008–09 recession a category 4, the same as recessions in 1953–54, 1981–82 and 1990–92. Perhaps surprisingly, of the four category 4 recessions, the Great Recession was the shortest, lasting only eight months from peak to trough versus 13 months, 17 months and 27 months, respectively, for the other three recessions (Cross and Bergevin 2012, table 1).

In terms of its effect on real GDP, the peak-to-trough drop during the Great Recession (4.6 percent) was deeper than in the 1953–54 and 1990–92 recessions (3.1 percent and 3.2 percent, respectively,) but less severe than the 1981–82 recession (5.4 percent).[4] GDP recovered more quickly in the Great Recession, reaching its pre-recession peak after a year and a half. The recovery from the 1981–82 and 1990–92 recessions were much more prolonged, taking more than two years in the former case and close to three years in the latter.

The main criterion other than real GDP by which to identify a recession is the change in overall employment. By that standard, the 2008–09 recession was particularly mild, with jobs contracting at only half the rate at which GDP fell. Employers relied equally on shorter workweeks and employment reductions to cut total hours (Cross 2011). The peak-to-trough decline in employment was only 2.5 percent in 2008–09 compared with 5.4 percent in 1981–82 and 3.1 percent in 1990–92.[5]

Despite this rosy picture, parts of the Canadian economy were hit hard. The reversal in commodity prices that took place in the last half of 2008 and an abrupt fall in export volumes contributed to declining business investment, which fell faster and further than in the two previous recessions (Boivin 2011, figure 5). The drop in exports was much more abrupt and severe than in other Canadian recessions since the Second World War, and was commensurate with a severe contraction in world trade during the recession (see Levchenko, Lewis, and Tesar 2010).

An Export-driven Recession

Let us look at this export-driven recession story in more detail. There is a strong case that the financial crisis in Canada was so minor that

4 Authors' calculations, using Statistics Canada, CANSIM database, tables 380 0064, 379 0027, and 379 0014.

5 Authors' calculations using Statistics Canada, CANSIM database, table 282 0087.

it would not have led to a recession without the precipitous drop in exports and concomitant drop in business investment. Even the fall in business investment can be explained to some degree by the decline in demand for exports and weak commodity prices rather than by a collapse in the willingness of Canadian banks to extend credit. Indeed, the Great Recession was characterized by a major collapse in world trade more severe than at any time since the Great Depression, with the exception of the Second World War (Baldwin 2009). Baldwin conjectures that the increasing importance of international supply chains explains much of this collapse. The financial crisis led to an immediate drop in demand in many countries for consumer durables and investment goods. In turn, this led to reduced demand for intermediate inputs of all types, which represent a relatively low fraction of world GDP but a very high fraction of world exports and imports. The drop in demand applied to almost all of world trade, but affected a relatively small fraction of world GDP, leading to a dramatic drop in the ratio of world trade to world GDP.

Canada did not escape this decline in exports, but experienced a drop commensurate with that in ten other major trading nations (Baldwin 2009, figure 3). The contribution of exports to the decline in Canada's GDP during the recession can be evaluated in a rudimentary way using basic national accounting. National accounting identities should not be confused with causal links, but decomposing Canada's GDP growth into the different components of aggregate demand can be informative. The basic national accounting identity can be written as follows:

$$Y = C + I + G + X - IM ,$$

where Y is GDP, C is consumption, I is investment, G is government spending, X denotes exports and IM denotes imports. This implies the following relationship between the rate of change in output and the rate of change of the components of aggregate demand:

$$\frac{\Delta Y}{Y}=\frac{\Delta C}{C}\frac{C}{Y}+\frac{\Delta I}{I}\frac{I}{Y}+\frac{\Delta G}{G}\frac{G}{Y}+\frac{\Delta X}{X}\frac{X}{Y}-\frac{\Delta IM}{IM}\frac{IM}{Y},$$

where, for example, $\Delta\frac{Y}{Y}$ gives the change in GDP expressed as a fraction of GDP itself. The contribution of the drop in exports to the decline in GDP can therefore be measured as the relative change in exports times the share of exports in GDP, or $\frac{\Delta X}{X}\frac{X}{Y}$. Table 5.2 summarizes the results of this exercise. Changes in GDP and exports are expressed in percentage terms. We see that the volume of Canadian exports began to drop in the third quarter of 2008, even though GDP growth remained positive. A decline of 0.25 percent in GDP meant that, if the other components of aggregate demand had changed at the same rate while exports remained constant, Canada's quarterly GDP growth would have exceeded 1 percent. The drop in exports in the fourth quarter accounted for more than the total drop in GDP, and the drop in the first quarter of 2009 by itself would have led to a 2.5 percent drop in GDP, more than the actual 2.3 percent drop. In the final quarter of the recession, the reduction in exports once again accounted for more than the total quarterly drop in GDP.[6]

The importance of exports to the recession can also be seen in the recovery. During the first quarter of the recovery, export growth was stronger than GDP growth as a whole, and accounted for over three-quarters of the quarterly rise in GDP. With the dramatic drop in export demand, business investment also fell

6 These calculations, of course, leave out the fact that inter-industry trade between Canada and its partners in the North American Free Trade Agreement, for example, plays an important role in the economy; they thus leave out the importance of Canadian imports to the overall production process.

Table 5.2: Contribution of Export Growth to GDP Growth, Canada, 2008: 2Q to 2009: 3Q, Percent

Quarter	GDP	Exports	Contribution
2008:2	0.35	0.85	0.28
2008.3	0.83	–0.78	–0.25
2008:4	–1.16	–4.59	–1.43
2009:1	–2.28	–8.63	–2.52
2009:2	–1.10	–4.05	–1.15
2009:3	0.45	2.68	0.77

Source: Statistics Canada, CANSIM table 380 0064, and Authors' calculations.

substantially – by about 20 percent in volume during the recession (Cross 2011). This decline was comparable to those in the 1981–82 and 1990–92 recessions, but the drop was more gradual in the two previous recessions, spread out over two years in 1981–82 and over three years in 1990–92. The steepness of the decline in exports during the Great Recession can be attributed to the steep fall in export demand.

The Great Recession in Canada Compared with Elsewhere

As noted, the Great Recession was severe in Canada, but no worse than some less notable downturns. What about in the United States and other industrialized countries? In the United States, the recession officially began in December 2007, according to the National Bureau of Economic Research (see NBER 2010), the official arbiter of business cycle turning points in that country. The trough of the Great Recession in the United States occurred in June 2009, so the recession lasted longer there than in Canada. Indeed, at eight months in length, Canada's recession was the shortest of any of the other G7 countries, where it ranged from 12 to 19 months (in the US case). The drop in Canada's GDP from peak to trough was 4.6 percent, while in the United States output fell by a fairly comparable 4.2 percent. Elsewhere among the G7 countries, the drop was also large, ranging from 3.7 percent in France to a whopping 8.4 percent in Japan.[7]

The peak-to-trough fall in output is, however, only one summary measure of the severity of a recession. Another way to determine the severity is to project potential output by log-linear extrapolation from the growth path a country was on before the onset of the crisis (Ball 2014b), from which one can measure both the difference between actual and estimated potential output in different countries at different times and the loss in potential output compared with the linear trend. By this measure, Canada's estimated output gap in 2013 was 0.75 percent, which put it well below the weighted average of a set of 23 OECD countries (2.56 percent). In 2013, however, Canada's potential output was 8.24 percent below its trend based on growth before 2007 – higher than the weighted average for Ball's 23-country sample (7.24 percent). In contrast, the United States experienced a larger output gap in 2013 (3.35 percent), but its potential output fell by just 4.70 percent. The lowest loss in potential output in 2013 was in Australia (1.4 percent), while Switzerland actually had a higher potential output (by 0.47 percent) than that based on log-linear extrapolation. The worst losses in potential

7 See Aiginger (2010); Cross (2010). Aiginger (2010, table 2) does a cross-country comparison of output losses that unfortunately omits Canada. We calculated Canadian and US output losses based on data from Statistics Canada and the US Federal Reserve.

output occurred in Greece (29.98 percent), Ireland (27.70 percent) and Hungary (25.69 percent).

These estimates neglect, however, long-run productivity growth and demographic factors, among others, that influence the growth of potential output. These factors might well have caused slowdowns in the growth of potential output even without the damage to capital accumulation and human capital caused by the Great Recession. We return to the issue of demographics in chapter 12.

Overall, for the most part Canada's recession compares favourably with that of peer countries.

Inflation during the Recession

We review one final topic in this chapter: inflation. In describing the Great Recession, it is easy to focus on sexier economic variables such as GDP and employment. But a book on monetary policy for an inflation-targeting central bank must keep an eye on the prize. For the Bank of Canada, that prize is the inflation target. So we ask, what was happening with inflation during the Great Recession (see Figure 2.1)?

Crude oil prices peaked at almost US$145 per barrel in July 2008. By December, they had fallen to less than US$40 per barrel. Much of this drop can be attributed to a drop in demand for oil and oil products due to the onset of the Great Recession itself. The effect of the oil price decline on Canada's CPI inflation was dramatic. Year-over-year headline inflation peaked at 3.5 percent in August 2008, outside the Bank of Canada's target band. By December 2008, it had fallen below target to 1.2 percent, and continued to fall, becoming negative by June 2009 and bottoming out at –0.9 percent in September 2009 before rebounding strongly the following month. The four months of negative year-over-year inflation (from July to September 2009) constitute the only example of deflation in the period covered by this study, and one of the few examples of outright deflation in the past sixty years.

The Bank's old measure of core inflation, so-called CPIX inflation, which excluded volatile components of CPI inflation such as gasoline, fuel oil and natural gas, remained above 1 percent during the whole recession, bottoming out at 1.2 percent in September 2009, after the recovery had already begun.[8] Much of the drop in CPI inflation can be attributed to declines in the prices of oil and other commodities, which were endogenous responses to the weakness of world demand.

The relative stability of inflation during the Great Recession can be called a "missing disinflation puzzle," applied to the United States by Coibion and Gorodnichenko (2015). In Canada, the decline in inflation up to September 2009 was in line with the median of a sample of 25 countries (Friedrich and Gosselin 2015), and can be explained, as noted above, by weak commodity prices. The rebound in inflation was also in line with the median of countries in Friedrich and Gosselin's sample and can be partly explained by commodity prices. The failure of core inflation to drop below 1.2 percent even in the presence of economic slack in the Canadian economy is part of the missing disinflation puzzle. One of the Bank of Canada's output gap measures, the integrated framework, turned negative in the second quarter of 2008 and has remained negative ever since. The Phillips curve relationship would predict a falling inflation rate in the face of excess capacity in the economy, but, as noted, core inflation never dropped below 1.2 percent.

In the United States, the historical behaviour of inflation can be reconciled with the Phillips curve by using data on household inflation expectations, which increased sharply starting in 2009

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8 The Bank's core inflation measure was superseded in 2015 by three different measures of core inflation; see Bank of Canada (2016b) for details.

(Coibion and Gorodnichenko 2015). One possible explanation for this is that such expectations are influenced strongly by fuel prices, but it is impossible to test this hypothesis for Canada in the absence of detailed data on these household inflation expectations. In upcoming chapters, we return to the story of missing disinflation during the financial crisis, and its twin puzzle, the "missing inflation" puzzle during the recovery period.

Chapter 6

The Bank of Canada's Response to the Recession

Before digging into the details of the Bank of Canada's response to the Great Recession, it is useful to provide some background on the different interpretations of how the recession came about.

The Monetarist Interpretation of the Great Recession

We have argued that the main shock responsible for the recession in Canada was the sudden drop in export demand. The ABCP crisis was a minor blip as far as overall demand was concerned and could not by itself have thrown the Canadian economy into recession. This leaves open the question of the recession's ultimate causes, and since it originated in the United States, the causes must be sought there.

There is no agreement concerning a single cause of the Great Recession. As Lo (2012, 151), in a survey of books about the financial crisis with which the recession began, states, "[n]o single narrative emerges from this broad and often contradictory collection of interpretations." There is consensus, however, about the different elements that came together to cause it.

The Current Consensus View

The consensus view – or what Congdon (2014) calls the mainstream view – is succinctly summarized by Christiano (2017), who identifies three main factors, none of which would have caused a major recession by itself, but combined created a "perfect storm." The first element was the decline in housing prices that began in the summer of 2007. Whether or not we characterize the run-up in housing prices before then as a bubble – and, as we discussed, the degree to which loose monetary policy contributed to the rise in housing prices remains controversial – the collapse of housing prices had a significant effect on different economies. The second factor was the financial sector's heavy investment in housing-related assets, including in derivative securities backed by mortgages. The third element was the vulnerability of the investment banks and shadow banking system, heavily invested in derivative securities, to runs.

The collapse in housing prices led to a rise in the rate of mortgage defaults in the United States, especially defaults on subprime mortgages. Rising default rates, in turn, led to doubts about the real value of certain opaque mortgage-backed securities. Different banks and shadow banks developed concerns over the creditworthiness of participants in the interbank credit market, which then froze as banks refused to extend short-term credit to many participants. The shadow banking system was forced to sell off assets at fire sale prices, which damaged the banking system's ability to finance not only mortgages but also investment more generally. Purchases of houses declined, which reinforced the downward spiral of house prices. Their wealth reduced, households cut back on purchases, and firms cut back on hiring and investment. As Christiano (2017) summarizes, the emerging consensus view of why the recession was so persistent is that nominal interest rates fell to unprecedentedly low levels, and short-term policy interest rates fell to their effective lower bound; inflation also fell dramatically, and prices were pushed lower by falling prices of oil and other commodities. Interest rates could not fall to balance the supply and demand for savings without a substantial drop in employment.

The Role of Monetary Policy in Worsening the US Recession

Whether or not the US Federal Reserve's accommodative policies earlier in the decade contributed to a housing bubble that led to the financial crash, a strong case can be made that the Fed's monetary policy during the first three quarters of 2008 was overly restrictive. This is the basis of the monetary view of the Great Recession, which remains far from the consensus view.[1]

The monetary narrative can be summarized as follows. The rise in oil prices in 2007 put upward pressure on inflation, and by June 2008 oil prices had more than doubled over the previous year. Because of the inflation scare, the Fed kept its target for the Federal Funds Rate relatively high throughout the first part of 2008, even though the US economy had already entered recession – as noted, in December 2007, according to the NBER (2010). Economic activity continued to fall throughout 2008, as did inflation, so real interest rates actually increased over the year. The decline in real activity accelerated throughout 2008. Payroll employment declined by 47,000 per month from January to March, by 207,000 per month from April to July, by 267,000 in August and by 434,000 in September, even before the failure of Lehman Brothers on September 15 (Hetzel 2012). The Fed Funds target was lowered to 2.00 percent in April 2008, but was kept constant until after the Lehman Brothers bankruptcy. It was lowered to 1.50 percent subsequent to an emergency meeting of the Federal Open Market Committee on October 8 and then lowered to 0.25 percent at its regular meeting on December 16. The Fed's restrictive monetary policy was compounded by an increase in the demand for liquidity

1 Its most persuasive advocates include Christensen (2011) Congdon (2009, 2011b, 2012) Hetzel (2009, 2012) Hummel (2011) Johnson (2011) and Sumner (2013, 2015). Lo's (2012) survey article on the financial crisis and its aftermath covers 21 books, but, as Congdon (2014) notes, not one of these books refers to a monetary aggregate.

in general and narrow money in particular due to a flight to safety starting with the ABCP crisis that struck in August 2007 and then accelerating with the failure of Lehman Brothers in September 2008 (see Beckworth 2010).

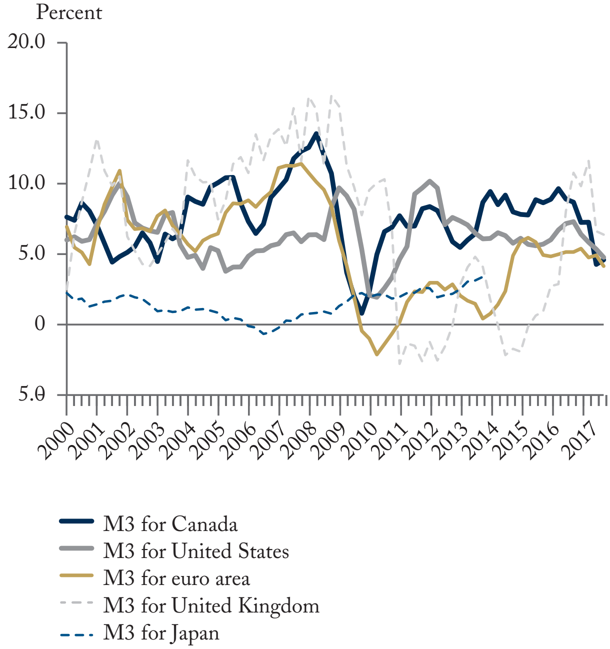
Shocks to the velocity of narrow money, as well as a drop in the money multiplier, were a leading indicator of the precipitous drop in nominal income that occurred starting in the fourth quarter of 2008, acting through Friedman's quantity theory equation discussed in Chapter 3. The recession then spread to other industrialized economies. In the case of Canada, as we discussed, a major impetus was the negative shock to the demand for Canadian exports. As Figure 6.1 shows, for Canada and many other major industrialized economies – including the United States,[2] the eurozone countries and the United Kingdom – broad money growth, after accelerating before 2008, started falling sharply in 2008 or early 2009.[3] This is important, as empirical evidence shows that broader measures of money are more tightly linked to nominal spending than are narrow measures (see Belongia and Ireland 2012, 2015; and Congdon 2009, 2010, 2011b, 2012, 2014). Correlation is not causation, but advocates of the monetary approach interpret the evidence to suggest that major central banks could have done more to ensure money growth did not fall, and that this might have contributed to turning a mild recession into the Great Recession.

The response of major central banks to the onset of the recession was guided by the importance they gave to the "credit channel" view

2 The United States stopped publishing data on M3 in 2006. This reinforces the idea that monetary aggregates are no longer seen as a useful input into the monetary policy process. The M3 series in the figure was calculated by the OECD, based on data provided by the Fed.

3 Japan is the exception here: the rate of growth of broad money in that country was already very low before the beginning of the financial crisis

Figure 6.1: Change in Broad Money Supply, Selected Economies, 2000–17



Source: US Federal Reserve.

of monetary policy transmission,[4] according to which the volume of bank loans determines aggregate spending and real activity. The key to getting the economy back on track was to extend credit to the banking system (including shadow banks) in order to unblock seized-up credit markets, reduce credit spreads between risky and safe assets and get the banks, other financial institutions, and markets to lend again.

4 See Congdon (2014) for a critique, Bernanke and Gertler (1995) for a broad summary and Bernanke and Blinder (1988) for an early statement.

The Fed, the Bank of Canada and other major central banks provided extraordinary liquidity facilities to major financial institutions that were experiencing difficulty obtaining short-term financing. The Bank of Canada's balance sheet expanded rapidly in late 2008 in conjunction with this provision of liquidity before shrinking back almost to its pre-crisis level by the middle of 2010. The Fed went further in deciding to accept low-quality collateral against loans to financial institutions, to charge subsidy (instead of penalty) rates for those loans and to rescue firms that were deemed too big to fail (such as Citigroup and AIG) without announcing a well-defined set of policies for how it would act as a lender of last resort (see Humphrey 2010 for an analysis). The lack of a set of *ex ante* policies led to moral hazard problems. One reason for the enormous impact of the Lehman Brothers collapse on financial markets was the widespread expectation that the firm would be bailed out, as Bear Sterns had been earlier the same year.[5]

The expansion of the Fed's balance sheet starting in 2009 was accompanied by a fall both in the money multiplier and in the velocity of circulation of most monetary aggregates. The fall in the money multiplier can be explained partly by the policy, introduced in October 2008, of paying interest to banks on their excess holdings of reserves.[6] This created a disincentive for banks to lend. In a climate with persistent low rates of return and high uncertainty, banks could earn low but safe rates of return by leaving reserves parked with the Fed. The Fed itself grew into a gigantic financial intermediary, essentially borrowing from the financial system in order to hold large quantities of non-traditional assets (such as mortgage-backed

5 See Roberts (2010) for details of the effect that the Bear Sterns bailout had on the market's assessment of the likelihood of a similar rescue of Lehman Brothers.

6 See Hummel (2011) and Johnson (2011) for penetrating analyses of this phenomenon.

securities) on its books.[7] The expansion of the Fed's balance sheet, as well as of narrow and broad measures of money, took place as part of three separate episodes of quantitative easing. This probably helped prevent a slump of the magnitude of the Great Depression, but nominal income in the United States remained on a permanently lower growth path than it was on before the onset of the recession (see Baldwin 2009, figure 3).

The credit channel also gave rise to an impetus to recapitalize the banking system. The push to recapitalize banks itself had the effect of putting the brakes on the rate of growth of broad measures of the money supply (Congdon and Hanke 2017; Hanke 2013). There are two reasons for this. First, banks can alter the composition of the liabilities side of their balance sheets either by raising new capital or by shrinking the size of their deposits. If they shrink their deposits, this obviously reduces broad measures of the money supply. If they raise new equity, investors typically exchange funds from bank deposits for bank shares, which also extinguishes money. Second, banks can also change the composition of the asset side of their balance sheets by holding more cash and government securities, which have lower capital requirements, and by reducing the size of their loan books, which will reduce the amount of multiple deposit creation familiar from money and banking textbooks. As Hanke (2013, 19–20) writes, "[s]o, paradoxically, the drive to deleverage banks and to shrink their balance sheets, in the name of making banks safer, destroys money balances. This, in turn, dents company liquidity and asset prices. It also reduces spending relative to where it would have been without higher capital-asset ratios."

As we have seen, the expansion of the Bank of Canada's balance sheet was related mostly to providing short-term liquidity to

7 Both Cochrane (2012) and Hummel (2011) judge that the Fed morphed during this period from a traditional central bank into a central planner that allocates funds preferentially by sector and by firm.

Canadian financial institutions, in line with the credit view of the transmission of financial shocks. Although we believe the Fed erred by focusing too much on this channel while paying no attention to monetary aggregates, the fact that the Great Recession was milder in Canada than in most industrialized economies – and, as we have seen, milder than some other Canadian recessions since the Second World War – means that the focus on liquidity provision, in our view, was entirely appropriate. We also note that the Bank's clear guidelines for its lending practices reduced the dangers of moral hazard.

The Response of Canadian Monetary Policy

With the backdrop to the Great Recession in mind, we now look at the Bank of Canada's response in greater detail.

The Bank started lowering interest rates in late 2007, but it was Mark Carney's very first interest rate decision as governor in March 2008 – a 50 basis point decrease that surprised markets – that began a sequence of precipitous falls, ending with the Bank's target overnight rate hitting what was then considered its effective lower bound of 25 basis points in April 2009. This was unprecedented in Canadian monetary policy history.[8] The Bank recognized that Canada had entered a recession in its April *Monetary Policy Report* (Bank of Canada 2009). It noted the availability of alternative instruments to the target overnight rate. In a speech in May 2009, Deputy Governor John Murray (2009) provided further details of these potential measures, which included the following.

- *Forward guidance*, which involved conditional statements about the future path of policy rates. In normal times, as part of its rate announcements or in its *Monetary Policy Report*, the Bank provides

8 To understand the Bank's thinking about monetary policy in response to the twin problems of the financial crisis and the recession, it is useful to look at the annex to the April 2009 *Monetary Policy Report* (Bank of Canada 2009).

general guidance about the future path of its policy rate. The Bank used this tool during the crisis by committing to keep rates low for as long as inflation remained low. The stated goal was to reduce longer-term interest rates, since these were largely a function of expected future short-term rates.[9] To reinforce its forward guidance, the Bank also issued one year PRAs at minimum and maximum bid rates corresponding respectively to the target rate and Bank rate.

- *Quantitative easing*, which involved the purchase of public sector securities through open market operations, at a pace that quickly grew the Bank's balance sheet and that was allowed to affect the central bank's reserve base. For the Bank, this implied increasing the level of settlement balances held there by banks. The stated goal once again was to push down the yield on those securities and to promote the expansion of loans by banks based on the increased reserves. This is now thought of as "unconventional" policy, but, as Murray (2009, 4) notes, it is the way monetary policy is described in many undergraduate textbooks and the way monetary policy was conducted "in the heyday of monetarism."
- *Credit easing*, which also involved purchasing securities – in this case private sector securities in particular markets suffering from severe dislocations and credit constraints. Pure credit easing would finance the purchase of these assets by selling assets already on the Bank's balance sheet, so that the size of the balance sheet would remain the same. This is known as "sterilization." Credit easing can be combined with quantitative easing, so both the size and composition of the Bank's balance sheet would be changed.

9 Murray (2009, 4) states that, for forward guidance to be effective, inflation expectations must remain well anchored. In fact, if credible forward guidance leads to expectations of a more rapid return of inflation to its target, it could be even more effective by increasing inflation expectations in the short run, thereby pushing down ex ante real interest rates and stimulating spending on consumer durables and fixed investment.

On April 21, 2009, as part of its forward guidance policy, the Bank announced it would maintain its overnight rate target at 25 basis points until the second quarter of the following year, conditional on the outlook for inflation. The Canadian economy reached the trough of the recession just one month later. The economy began growing again in June, but, as noted, consumer prices continued to decline until September.

In addition to a heavy reliance on forward guidance, the Bank rapidly expanded its balance sheet during the heart of the crisis, primarily, as we showed in Chapter 5, through its Term Purchase and Resale Agreement, part of a broad strategy to provide emergency liquidity to the market. From September 2008 to April 2009, the Bank's balance sheet expanded by just over 50 percent (Gordon 2009). Looking at the liabilities side, the bulk of the increase was in federal government deposits, which are not part of the monetary base. The time path of notes in circulation barely changed. By July 2010 the balance sheet had shrunk in size to the time path it had been on before the crisis (Gordon 2010). As we noted earlier, and reiterate here, the Bank also brought the overnight rate target to the bottom of the corridor (as opposed to the middle), and increased the level of settlement balances from \$25 million to \$3 billion to validate that target. Because the Bank did not intend to use this increase in reserves in a direct fashion to affect yield spreads between long- and short-term government debt or to encourage lending, this action is not generally regarded as an attempt at quantitative easing. It was, however, unconventional – a departure from monetary policy in normal times.

On April 20, 2010, the Bank maintained a target rate of 25 basis points, but removed its conditional commitment to stay at that level. At that point, the recovery from the recession had been under way for 11 months. At the time of the announcement, the Bank predicted that the Canadian economy would grow by 3.7 percent over the course of 2010. It also noted:

> With its conditional commitment introduced in April 2009, the Bank also provided exceptional guidance on the likely path of its target rate. This unconventional policy provided considerable additional stimulus during a period of very weak economic conditions and major downside risks to the global and Canadian economies. With recent improvements in the economic outlook, the need for such extraordinary policy is now passing, and it is appropriate to begin to lessen the degree of monetary stimulus. The extent and timing will depend on the outlook for economic activity and inflation, and will be consistent with achieving the two percent inflation target. (Bank of Canada 2010a.)

The Bank finally raised its overnight rate by 25 basis points on June 1, 2010, the next announcement date. This also permitted the Bank to re-establish the ordinary functioning of the corridor system. This meant that the operating band reverted to 50 basis points (between 0.25 percent and 0.75 percent). It also meant a reduction in the target for overnight settlement balances from $3 billion to $25 million. And, lastly, it meant a reduction in the size of the Bank's balance sheet as emergency liquidity facilities were wound down during the summer of 2010.

The Bank thus maintained a dichotomy between its monetary policy (flexible inflation targeting) and its role as lender of last resort in response to the financial crisis.[10] The corridor system allows the Bank to provide liquidity to banks while maintaining its target for the overnight rate.[11] Of note was the Bank's close monitoring of how effective low policy rates were in stimulating movement in the cost of credit to businesses and households. In normal times, credit spreads are fairly consistent, and movement in the policy rate tends to move other rates simultaneously. In crisis periods, the

10 See Melino (2012) on the dichotomy between monetary policy and the Bank's reaction to the financial crisis.

11 See Kahn (2010) for the details on how the size of the central bank's balance sheet can be varied while maintaining a constant policy rate.

spreads become unhinged, and it is crucial to see how policy rates affect other rates that form the basis of household and business borrowing. To that end, the Bank maintained a special section on credit conditions on its website, and reported credit conditions regularly in its *Monetary Policy Report*.

The Role of Fiscal Stimulus

Central banking and its macroeconomic effects can be complex, but the effects of fiscal stimulus might be even more contentious. We explain why, but ask the reader to keep in mind that what is not controversial is that fiscal policy has a significant impact on the effectiveness and transmission of monetary policy.

There are those who latch onto the teachings of Mundell and Fleming, in which fiscal policy is completely ineffective in a small, open economy under perfect capital mobility with flexible exchange rates.[12] This basic insight extends from the Keynesian models of Mundell and Fleming to more modern New Keynesian models. And there is empirical evidence to back it up. For example, Ilzetzki, Mendoza, and Vegh (2013) estimate fiscal multipliers for a panel of countries, and find that for small, open economies with flexible exchange rates, the fiscal multiplier is negative in the short run and insignificantly different from zero in the long run.

Even for Keynesian economists, the role of budget deficits can complicate things. As our predecessors explain (for example, Laidler and Robson 2004), when budget debt and deficits are relatively low, as they were from the mid-1950s to the 1970s, consumers and businesses do not worry about the future effects of present-day deficits. That is to say, they do not worry about saving more now to

12 See Mundell (1963); "Two Out of Three Ain't Bad: The Mundell-Fleming Trilemma," Economist, August 27, 2016 and Mao Takongmo (2017) for the case of the short-term interest rate at its lower bound.

pay for inevitable tax hikes down the road. In such an environment, fiscal stimulus is much more likely to have the desired positive effects on aggregate demand. As deficits and debt climb, however, as they did in the late 1980s – concerning some, such as Purvis (1985) – consumers and businesses begin to worry, and are likely to slow spending. Increased fiscal stimulus is then unlikely to stimulate any additional demand.

This backdrop leads us to the financial crisis and Canada's fiscal response. As the Canadian economy entered into recession, the federal and provincial governments responded with stimulus packages. The most ambitious was the federal government's *Economic Action Plan*, a two-year, $47.2 billion stimulus package introduced in the first quarter of 2009 (see Karabegović, Lammam, and Veldhuis 2010). The package consisted of a combination of tax reductions and spending, both on infrastructure and to stimulate housing investment.

As we showed in Chapter 1 (Figure 1.12), the budget was in surplus from the late 1990s until the beginning of the crisis. If we follow the Keynesian logic above, there would have been room for fiscal stimulus to act in a positive fashion on aggregate demand during the crisis. The overall effect of fiscal stimulus in Canada during the recession is, however, controversial. GDP growth went from –1.1 percent in the second quarter of 2009 to 0.45 percent in the third quarter, bringing an end to the recession. A decomposition of the 1.55 percentage point increase in growth between the two quarters shows that only about 0.2 of a percentage point of the increase in demand can be attributed to increases in government spending at all levels. This should be viewed as solely an accounting decomposition. It is possible that multiplier effects of government spending increases led to even larger increases in private consumption and investment spending. It is also possible that tighter fiscal policy abroad slowed down foreign economies, and Canada, as a small, open economy, suffered the consequences. The difficulty is in trying to separate all these things.

Regardless of where one comes out on the merits of fiscal policy, the federal government slowly wound down the recession-led deficits, and by 2014 they had disappeared. Why does this matter for monetary policy? As Poloz (2016) shows, in models of the economy with government debt, higher liabilities generate greater incentives for government to create inflation, because higher inflation reduces the real value of their debt; however, it also reduces the real value of private sector holdings of debt, and puts a wrecking ball to inflation expectations. That said, the Bank of Canada's commitment to a target, and the credibility it has developed over the past 25 years, has helped anchor expectations to offset the effect of government debt. Additionally, an inflation target has led to lower levels of government debt, all else being equal.

There is always the difficult question of what the appropriate mix of monetary and fiscal policy should be. At the end of the day, however, what we can say is there is a strong link between monetary and fiscal policy, which will play an important role in assessing the Bank of Canada's actions during the recovery phase – to which we turn next.

PART III

Aftermath: Recovery from the Great Recession

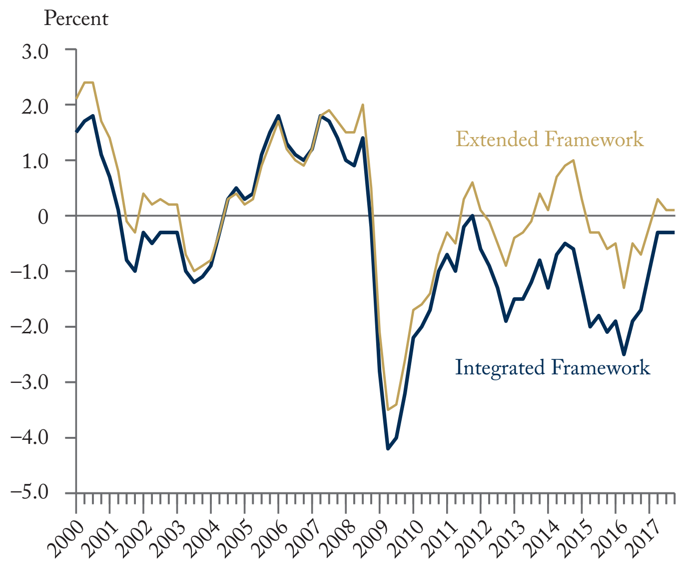
Chapter 7

The Slow Recovery of the Industrialized Economies

The Great Recession was Canada's first downturn after an uninterrupted expansion that had lasted 16 years. Although the recession was less severe than in many other countries, the recovery has been slow, and inflation – as we have discussed – remains stubbornly low. At the time of writing, it has been ten years since the beginning of the Great Recession, and eight years since the recovery began, depending on the country. But this recovery has been much different than previous ones, highlighted in many countries, including Canada, by sluggish real growth and inflation rates systematically below their targets. Inflation has remained low despite rock-bottom policy rates in both developed and developing countries. These historically low interest rates have been reinforced not just by below-target inflation, but also by an output gap that refuses to close – Canada's output gap from the first quarter of 2000 to the fourth quarter of 2017 is shown in Figure 7.1 (also presented in Chapter 1 as Figure 1.2). One of the two measures of the output gap that the Bank of Canada uses, the so-called integrated framework, has remained negative since the beginning of the Great Recession.

Due to the persistence of these negative economic outcomes, the Bank of Canada and other central banks have gone beyond conventional monetary policy to use such tools as forward guidance, negative policy rates and quantitative easing. In Canada's case,

Figure 7.1: The Output Gap, Canada, 2000–17



Note: The extended multivariate filter uses purely statistical methods to smooth actual output growth in order to generate a smoothed measure that is taken to be potential output; the integrated framework looks at trend growth in labour inputs and labour productivity. See Pichette et al. (2015).

Source: Bank of Canada.

aside from the experience with forward guidance we documented in Chapter 6 and the short-lived balanced-sheet expansion during the height of the financial crisis, the Bank has not actually engaged in the unconventional monetary policies of central banks such as the US Federal Reserve and the European Central Bank. It has, however, published its views on the types of unconventional policies it would use if the need arose (see Bank of Canada 2015b; Poloz 2015b).

We begin this chapter by documenting the slow recovery from the Great Recession. We then consider some of the explanations for the slow recovery, and end with a general discussion of the implications of a low-interest-rate world for monetary policy.

Documenting the Slow Recovery

In its 2016 *World Economic Outlook*, the International Monetary Fund (IMF 2016) documents the slow recovery around the world since the end of the Great Recession. Table 7.1, taken from the IMF report, shows the behaviour of output. For advanced economies as a whole, the only year for which GDP growth was higher than the 1998–2007 average was 2010, the first full year of the recovery. In the United States and the Euro Area, growth rates to 2016 never matched the average for the 1998–2007 period, even at the beginning of the recovery – a time when growth is usually faster than normal as the economy catches up with trend growth. Japanese growth exceeded its 1998–2007 average in 2010, 2012 and 2013, but only because the country's average growth in the earlier period had been particularly anemic. Canada's growth almost matched the 1998–2007 average in both 2010 and 2011, another indication that Canada's recession was relatively mild by international standards. Canada's growth rate also exceeded the average growth rate of advanced economies between 2011 and 2014. Since 2012, however, GDP growth in Canada has been below its historical average. Canada's growth rate in 2015 was the lowest of the individual economies in Table 7.1, except for Japan, due to the negative shock to world oil prices (which we take up in Chapter 9).

Table 7.2, also taken from the IMF (2016) report, shows the behaviour of inflation during and after the Great Recession. The pattern is similar across countries, and illustrates the two "inflation puzzles" of the post–Great Recession recovery (Friedrich and

Table 7.1: Real GDP Growth Rates, Selected Economies, 2008–15, Percent

Region/ Country	Average, 1998–2007	2008	2009	2010	2011	2012	2013	2014	2015
Advanced Economies	2.8	0.2	–3.4	3.1	1.7	1.2	1.2	1.8	1.9
USA	3.0	–0.3	–2.8	2.5	1.6	2.2	1.5	2.4	2.4
Euro Area	2.4	0.5	–4.5	2.1	1.6	–0.9	–0.3	0.9	1.6
Japan	1.0	–1.0	–5.5	4.7	–0.5	1.7	1.4	0.0	0.5
Other Advanced	3.6	1.1	–2.0	4.5	3.0	1.9	2.3	2.8	1.9
Canada	3.2	1.0	–2.9	3.1	3.1	1.7	2.5	2.9	1.0

Note: The advanced economies in the table are made up of 39 countries: for the complete list, see IMF World Economic Outlook 2016, 168.

Sources: IMF World Economic Outlook 2016, appendix A1; and (for Canada) authors' calculations.

Gosselin 2015).[1] The first puzzle is the "missing disinflation" of the recession itself. Inflation in all economies dipped during 2009, with some dips more pronounced than others. By 2010, however, many had already recovered. Canada's case highlights the oddity of this quick recovery, since, as we saw in Figure 7.1, the output gap remained negative, which is not usually a recipe for inflation above target.

The second puzzle is one of missing inflation. With output gaps gradually closing after 2012 (but widening again in Canada in 2015

1 On the first inflation puzzle in the United States, see Coibion and Gorodnichenko (2015); on the second puzzle, see IMF (2013).

Table 7.2: CPI Inflation Rates, Selected Economies, 2008–2015, Percent

Region/ Country	Average, 1998–2007	2008	2009	2010	2011	2012	2013	2014	2015
Advanced Economies	2.0	3.4	0.2	1.5	2.7	2.0	1.4	1.4	0.3
USA	2.6	3.8	–0.3	1.6	3.1	3.1	1.5	1.6	0.1
Euro Area	2.0	3.3	0.3	1.6	2.7	2.5	1.3	0.4	0.0
Japan	–0.2	1.4	–1.3	–0.7	–0.3	0.0	0.4	2.7	0.8
Other Advanced	1.9	3.9	1.4	2.4	3.3	2.1	1.7	1.5	0.6
Canada	2.2	1.2	1.3	2.3	2.3	0.8	1.2	1.5	1.6

Sources: IMF World Economic Outlook 2016, appendix A5; and (for Canada) authors' calculations.

due to the 2014 oil price shock), inflation remained quite muted.[2] Table 7.3 shows the inflation numbers at around the middle of 2017, the latest available at the time of writing, compared with targets as calculated by the OECD. Of the 25 countries in the table, 18 had realized rates of inflation below target. In the seven countries with rates higher than target, all except the United Kingdom had rates higher than 4 percent. There are exceptional explanations for some of these cases, such as the monetization of high budget deficits in Mexico and Turkey or, in the United Kingdom, the effects

2 This can be seen in Figure 7.1 for the integrated framework measure of the output gap. The extended multivariate filter measure was positive before the 2014 oil price shock, but turned negative in 2015.

Table 7.3: Inflation Targets and Realized Inflation Rates, Selected Countries, 2017, Percent

Country	Target	Realized	Gap	Date
Australia	2–3	1.9	–0.6	05/2017
Brazil	4.5 +/– 1.5	3.6	–0.9	05/2017
Canada	2 +/– 1	1.3	–0.7	05/2017
Chile	3 +/– 1	2.6	–0.4	05/2017
China	~3	1.5	–1.5	05/2017
Columbia	3 +/– 1	4.4	1.4	05/2017
Czech Republic	2 +/– 1	2.4	0.4	05/2017
Eurozone	< 2	1.4	–0.6	05/2017
Hungary	3 +/– 1	2.1	–0.9	05/2017
Iceland	2.5	1.5	–1.0	06/2017
India	4 +/– 2	1.1	–2.9	05/2017
Indonesia	4 +/– 1	4.4	0.4	06/2017
Israel	1–3	0.8	–1.2	05/2017
Japan	2	0.4	–1.6	05/2017
Mexico	3 +/– 1	6.2	3.2	05/2017
New Zealand	2 +/– 1	2.2	0.2	Q1/2017
Norway	2.5	2.1	–0.4	05/2017
Poland	2.5 +/– 1	2.0	–0.5	05/2017
Russia	4	4.1	0.1	05/2017
South Africa	3–6	5.3	0.8	05/2017
Sweden	2	1.7	–0.3	05/2017
Switzerland	< 2	0.5	–1.5	05/2017
Turkey	5 +/– 2	10.9	5.9	06/2017
United Kingdom	2	2.9	0.9	05/2017
United States	2	1.9	–0.1	05/2017
Median Gap			–0.45	
Above Target			8/25	
Below Target			17/25	

Note: For the two central banks (the Swiss National Bank and the European Central Bank) that express their targets as ceilings (both have targets of inflation rates near but less than 2 percent), we calculated the gap as the difference between the realized inflation rate and the target ceiling.

Sources: OECD, http://stats.oecd.org/index.aspx?queryid=22519; inflation targets are from Central Bank News, http://centralbanknews.info/p/inflation-targets.html.

of exchange-rate depreciation due to the Brexit referendum. The median gap between target and realized inflation was –0.45 percent. Canada's gap was larger (that is, more negative) than the median, and negative since 2012.

The slow recovery in the United States and elsewhere has led some to propose that such low growth rates might be permanent. This hypothesis, known as the Great Stagnation hypothesis (Cowen 2011; Gordon 2015; Summers 2014, 2015), is not without controversy. We turn now to an explanation of some of the proposed reasons for the slow recovery and where we stand on the issue.

Explaining the Slow Recovery

Supply-side and demand-side explanations of the slow recovery seem to pit one side against the other, but in reality they can coexist. It is, in fact, possible to distinguish broadly between supply-side and demand-side explanations (Lo and Rogoff 2015) while realizing that both are crucial in describing the sluggish real economy since the financial crisis.

Supply-Side Explanations: The Growth of Potential Output

The growth of potential output depends on the growth of inputs into the production process (primarily capital and labour) and on the efficiency with which these inputs can be combined to produce output. Taking it a step further, Gordon (2015) focuses on the efficiency of productive inputs (the growth of total factor productivity). He claims that there have been three significant "industrial revolutions" in economic history. The first, associated with steam and railroads, lasted from 1750 to 1830. The second, from 1870 to 1900, was the most important in terms of boosting productivity, and saw the introduction of electricity, the internal combustion engine and many other significant innovations. The third revolution began in 1960, and is associated with computers, the Internet and mobile phones. In Gordon's estimation, the benefits of the third revolution are now all but exhausted and, as a result, per capita GDP growth will remain permanently lower. Whether or not one agrees with this analysis, in another paper Gordon (2014) identifies four "headwinds" that undeniably have resulted in slower supply-side growth:

- *demography*: population growth has been slowing down in advanced economies, leading to a commensurate slowdown in labour force growth;
- *education*: advanced economies have already attained high rates of post-secondary education, so the rate of growth of human capital is lower and likely will continue to remain so;
- *public debt*: governments in advanced economies are highly indebted, leaving little room for further growth in public services;
- *inequality*: much of recent growth has accrued to individuals in the top decile of the income distribution; below the top 10 percent, incomes (and labour productivity) have been stagnating.

These effects have caused a drop in the level of full-capacity output. Recessions typically are periods of low or negative net business investment, which lowers the productive capital stock and thereby reduces full-capacity output. Unless higher-than-normal investment leads to a complete reversal of the reduction in capacity, the effect is permanent.

Demand-Side Explanations: Shortfalls in Demand

Demand-side explanations for the slow recovery are about the gap between potential and actual output. As we noted above, in Canada's case the output gap (as measured by the integrated framework) has remained negative since the Great Recession.

One popular demand-side explanation for slow growth points to the effects of being stuck at the effective lower bound. The basic argument is simple. For much of the period of the recovery from the Great Recession, the effective lower bound on policy rates prevented central banks from lowering rates to the point where the *ex ante* real interest rate was as low as or lower than the short-run neutral rate. It is this differential that is key to stimulating aggregate demand. Although this is a popular line of argument, it is by no means the only one that explains weak aggregate demand and low or negative market real interest rates.

Another possible explanation for the slow recovery has to do with the fact that the recession originated in a financial crisis (Lo and Rogoff 2015). Households and firms had high levels of debt going into the recession, and engaged in deleveraging during the recession and continued to do so into the recovery. This depressed demand for consumption and investment goods increased the savings rate and put downward pressure on equilibrium interest rates.

Others have advanced the argument that the Great Recession gave rise to an acute shortage of safe assets (Caballero and Farhi 2014; Gourinchas 2017). Assets that had been considered safe, such as mortgage-backed securities, were revealed by the financial crisis to be risky. The financial engineering that led to the expansion in the supply of mortgage-backed securities was itself driven by burgeoning demand for safe assets due to demographic factors, a rise in international reserve holdings by many central banks, and regulatory changes. Problems with sovereign debt during the Great Recession moved the debt of some countries, such as Italy and France, from the safe to the risky column. This contributed to depressing the real natural rate of interest.

The issue of changing demographics is also prominent in an IMF (2012) explanation for weak aggregate demand during the recovery. Much of the increase in life expectancy in recent years has been unanticipated. Consequently, individuals and households have been faced with planning to stretch their accumulated savings over a longer period. This, in turn, has contributed to increased world savings rates, which has driven down equilibrium interest rates.

Although the studies behind these proposals do not focus on Canada, they all cover issues Canada has faced in the years since the crisis. Demographics, in particular, will continue to act as a drag on the demand side. What is also clear from these aggregate demand stories is they do not preclude supply-side explanations, with the two together contributing to the slow-growth recovery we have experienced.

Low Natural Interest Rates

From the point of view of monetary policy, one main consequence of permanent low growth is that, in the long run, the neutral rate of interest will be lower, and equal to the long-run riskless real interest rate plus the central bank's inflation target. This is an implication of standard growth theory, which holds that the main factors determining real interest rates in the long run are preferences (the degree of impatience of individuals and households) and real growth. Ambler and Alexander (2015), who look at the theoretical arguments and the implications for the Canadian economy, find that the long-run neutral rate in Canada might have fallen to approximately 3 percent. The Bank of Canada estimates that in 2014 the long-run real neutral interest rate in Canada was between 1 and 2 percent (Mendes 2014), meaning that, with an inflation target of 2 percent, the long-run nominal natural interest rate in Canada is in the range of 3 to 4 percent. At the time of writing, the Bank's estimate of the long-run (nominal) neutral interest rate had fallen to between 2.5 and 3.5 percent (*Monetary Policy Report*, July 2017). The 2014 report (Mendes 2014) mentions that the neutral rate was a full percentage point below where it was in the mid-2000s, meaning 1.5 percentage points below what it was at the time of writing. This has consequences for monetary policy at the Bank, a topic we turn to next.

Broad Implications for Monetary Policy

We have argued that the slow economic recovery since the Great Recession can be explained by a combination of demand-side and supply-side factors. This leads us to consider the effectiveness of monetary policy during the recovery and whether the inflation-targeting paradigm is still the appropriate monetary policy framework for the future. We focus on the effect of lower neutral rates, as we see these as critical for both a historical explanation and future monetary policy success.

One issue for the future is that, purely as a matter of simple statistics, the zero lower bound will bind more often with lower long-term natural interest rates (see Kiley and Roberts 2017).[3] In the United States, the average Federal Funds Rate (the Fed's policy rate) between 1960 and 2007 was 6.1 percent, with a standard deviation of 3.25 percent. If the rate followed a normal distribution, it would be equal to or less than zero 3 percent of the time.[4] If the average Federal Funds Rate were to fall to 3 percent with no change in its dispersion, it would be equal to or less than zero almost 18 percent of the time! As we have argued, the effective lower bound constrains a central bank's ability to hit its inflation targets consistently.

For Canada, the situation is probably less dramatic. Using the sample period 1994–2007, which excludes the high-inflation period of the 1970s and early 1980s, the mean value of the Bank Rate was 4.39 percent, which implies a mean for the target overnight rate

3 We use natural rate of interest and neutral rate interchangeably, and define them as the rate that would keep the economy operating at potential/full employment with inflation stable.

4 More exactly, the value of the cumulative normal distribution at zero with a mean of 0.061 and a standard deviation of 0.0325 is 0.030.

of 4.14 percent.[5] The standard deviation of the Bank Rate over this period was 1.43 percent, implying that the probability of the target overnight rate's being zero or lower (if normally distributed) was approximately 0.1 percent. Even if the neutral rate were at the low end of the Bank's current estimated range (2.5 percent), the probability of a zero or negative target overnight rate would still be only about 4 percent, and this probability would increase to only about 8 percent with a long-run neutral rate of 2 percent.

Despite this rosier picture for Canada, the natural implication of lower neutral interest rates is that inflation-targeting central banks will find it more difficult to achieve their targets. Even if central banks hit their targets on average during periods when the effective lower bound was not binding, averaging over periods when policy rates were above their lower bound and periods when they were constrained by the lower bound would lead to average inflation rates below target.

This suggests a more radical rethinking of the monetary policy framework is needed to prepare for future shocks that push interest rates to their lower bound. In the following subsections, we discuss the main contenders – that is, aside from the control of a short-term policy rate – that central banks have considered as tools either to achieve inflation targets or as alternative monetary policy frameworks. Since current orthodoxy sees monetary policy as the setting of a short-term interest rate that a central bank determines will return inflation to its target, these policies have come to be known collectively as unconventional monetary policies. All of these policies were implemented by one or more central banks in response to the financial crisis, and all central banks, including the Bank of Canada, as we noted in the introduction to this chapter,

5 Historical statistics for the Bank Rate are available on the Bank of Canada's website at http://www.bankofcanada.ca/wp-content/uploads/2010/09/selected_historical_v122530.pdf.

have analyzed the effects of unconventional monetary policies as they consider their options to respond to future crises.

Unconventional Monetary Policies: Forward Guidance

Forward guidance involves announcing a path for the short-term policy rate, rather than just its current value. The basic idea behind the use of forward guidance can best be explained in the context of a crisis such as the Great Recession, when policy rates are at their effective lower bound. Committing to keeping interest rates low even after a recovery is well under way and inflation has increased to a level close to the target will push down longer-term interest rates and stimulate spending, helping to accelerate the recovery.

In one sense, forward guidance is not a radically new or different policy: central banks in New Zealand, Norway and Sweden, for example, publish conditional interest rate forecasts as a regular part of their communications to the public. Svensson (2006) maintains that conditional interest rate forecasts should be an integral part of inflation-targeting regimes, to which we agree. He writes: "Since the optimal projection is the best projection in the sense of minimizing expected squared forecast errors, it also provides the private sector with the best aggregate information for making individual decisions. Announcing the optimal projections also allows the most precise and sophisticated external evaluation of the monetary-policy framework and decisions" (2006, 185–6).

Although forward guidance proved successful during the financial crisis, the slow-growth recovery has put a damper on the longer-term success of the strategy – at least in the context of "lower for longer" without specified conditions for removing the policy. There are several potential drawbacks to a policy of "lower for longer" used to boost spending and inflation when the central bank's policy rate is at its effective lower bound, which might explain the lack of longer-term success.

The first drawback – a problem for the orthodox view on its own terms – is that of time consistency. If lower future interest rates succeed in encouraging spending, which causes inflation to return to target more quickly, the central bank will be strongly tempted to deviate from its promised interest rate path in order to prevent inflation from overshooting the target. Once the announcement of the interest rate path has had the desired effect on spending, it is in everyone's interest for the central bank to renege on its promise. If households and firms realize this, however, the announcement of the interest rate path will not be credible, and in fact will not have the desired effect on aggregate demand.

The second problem relates to the appropriateness of the orthodox view in the first place. From a monetarist perspective, interest rates are notoriously unreliable as indicators of the stance of monetary policy, as Milton Friedman famously argued many times throughout his career. In the context of Japan in the last decade of the twentieth century, he wrote: "Low interest rates are generally a sign that money has been tight, as in Japan; high interest rates, that money has been easy" (Friedman 1997; see also Friedman 1998, 2003). Indeed, as we discussed earlier, there is debate as to whether Canada was overly stimulative in the early part of the 2000s leading up to the crisis, despite continual increases in the overnight rate. As well, despite being near the zero lower bound post-crisis, we have not seen the spending growth characteristic of an economy rebounding from a recession.

The effects of forward guidance are most often thought to work through the term structure of interest rates. They lower the expected path of short-term interest rates and, to the extent that longer-term rates are (absent term premiums) averages of current and future expected short rates, announcing a path of "lower for longer" has the main effect of stimulating demand by reducing longer-term interest rates and yields. In the context of the effective lower bound, however, even an announced path of a policy rate at its lower bound for an extended period would not reduce longer-term rates all the way to zero, let alone push them into negative territory. The problem with this policy is that, for the economies most severely affected by the Great Recession, including the United States, the short-term neutral rate of interest was likely highly negative, and required more stimulus than was given. Cúrdia (2015) estimates that, in the United States, the short-term natural (or equilibrium) interest rate was as low as –4 percent during the Great Recession and in the early stages of the recovery.

Probably largely because equilibrium interest rates can become highly negative in periods of financial and/or real economic stress, central banks have started to entertain the possibility of negative policy rates. Some central banks – notably those of New Zealand, Norway and Sweden – have actually implemented these policies.

Unconventional Monetary Policies: Negative Interest Rate Policies

Negative interest rate policies have to do with pushing the effective lower bound on policy rates below zero. During the Great Recession, the Bank of Canada judged that, to ensure the smooth functioning of money markets, it could not reduce the overnight target below 25 basis points, which is where it remained between April 2009 and June 2010.

Traditionally, zero has been viewed as the effective lower bound because, instead of holding reserves at the central bank, banks and individuals always have the option of holding cash, which by definition yields a nominal rate of return of zero.[6] However, this neglects the costs of storing large amounts of cash, as well as

6 Some authors (for example, Buiter and Panagirtzoglou 2003) have proposed somewhat esoteric ways of taxing currency holdings in order that the nominal rate of return becomes negative.

the security costs. Once these are taken into account, it is clear that the holding of reserves could be subjected to negative rates of return without creating an incentive for individuals to switch to cash holdings. Witmer and Yang (2016) estimate that the Bank of Canada's effective lower bound in 2016 was –50 basis points, instead of the 25 basis points the Bank took to be its effective lower bound in 2009.

The next logical step towards pushing interest rates even lower is the idea of abolishing cash, in order to be able to push policy rates even lower. Rogoff (2015), one of the main advocates of this idea, justifies it as a means both of fighting crime and of tightening monetary control. We are in uncharted territory here, however, and not all of the possible unintended consequences of abolishing cash have been explored or thought through fully (for a critical review, see El-Erian 2016).

Unconventional Monetary Policies: Quantitative Easing

The final type of unconventional monetary policy we consider is quantitative easing, also known as "large-scale asset purchases." QE involves the expansion of a central bank's balance sheet by purchasing large amounts of securities. These can be either government securities or other financial assets issued by the private sector, and the purchases can be made either using traditional open market operations in the banking sector or directly from individuals and firms in the private sector.

The US Federal Reserve and other central banks, including the European Central Bank, have employed QE extensively; to a lesser extent, so has the Bank of Canada. Proponents of QE claim its main benefit is its effect on the term structure of interest rates – the "interest rate channel." The Bank has studied the possible use of QE in future crisis situations as well. Poloz (2015b, 4–5) describes the effects of QE as follows: "First, they create new liquidity in the banking system, which can increase the availability of credit. Second, large-scale asset purchases tend to lower the interest rates on the purchased assets, and on other types of debt of similar duration, which in effect flattens the yield curve, bringing longer-term interest rates down closer to short-term interest rates. Third, such purchases of assets tend to put downward pressure on the exchange rate." In contrast, after a survey of the large empirical literature on the issue, Thornton (2015) judges – correctly, in our view – that QE's effects on the term structure of interest rates have, in fact, been very weak, measured as decreases of tens of basis points on longer-term yields. Changes of this order of magnitude are likely to have trivial effects on demand and output.

QE's lack of effectiveness might be explained by issues with the credit channel, which monetarists view as of secondary, or even negligible, importance. Specifically, it is clear that QE, in its use until now, was designed to be temporary – Beckworth (2014), for example, shows this to be the case on the part of the US Federal Reserve. There is a well-established literature that shows why temporary QE should have very weak effects. For example, Ambler (2016) shows, in a theoretical model, that temporary QE will not have strong effects, while a more monetarist approach of making permanent increases in the monetary base via open market operations would have immediate, strong effects on inflation and output. In Chapter 8, we discuss in more detail why QE, used appropriately, could have strong real effects, and suggest why it is the best monetary framework for boosting demand in a low-interest-rate environment.

Conclusion

As we have documented, the recovery from the Great Recession has been characterized by slow growth and low inflation, and by inflation rates that seem divorced from cyclical movements in output and unemployment. A combination of supply-and-demand factors explains the anemic nature of the recovery in Canada and other industrialized countries. This slow growth has led to lower neutral rates of interest, which will make it harder for central banks to hit their inflation targets in the future. The economic environment has also led to the use of certain unconventional monetary policy strategies, which we study in more detail in the next chapter.

Chapter 8

Monetary Policy in a Low-Inflation, Low-Interest-Rate Environment

In the previous chapter, we laid out the challenge of a low-interest-rate environment in terms of the difficulty hitting the inflation target. Earlier in the book, we discussed the tension in a low-interest-rate environment between the primary goal of monetary policy (hitting the inflation target) and financial stability concerns (low interest rates can cause a build-up of credit). How best to apply monetary policy itself in the context of this low-interest-rate environment, keeping all these concerns in mind?

Depending on the performance of the Canadian economy and the outlook for inflation, the Bank of Canada might be faced in the near future with the need to provide monetary stimulus in an environment with a very low or even negative overnight rate. Here we expand on why the Bank should use quantitative easing – on a longer-tem, rather than temporary, basis – to affect inflation expectations and spending via increasing the broad money supply in order to encourage spending on goods and services by individuals and firms. QE can stimulate the economy without having to drive down interest rates into dangerous negative territory.

Bank of Canada Governor Stephen Poloz (2015b) signalled the possibility of using negative interest rates as a policy tool in a speech in December 2015, but there is a limit to how low they can go. Indeed, as we noted in the previous chapter, Witmer and Yang

(2016) peg the effective lower bound at –50 basis points. Wherever that lower bound might be, farther down the road the Bank might face the need to provide monetary stimulus without lowering rates. The Bank would then find itself in a situation similar to that during the Great Recession, when the presumed lower bound of 25 basis points remained in place between April 2009 and the beginning of June 2010. The policy rates of other central banks have been close to or at their effective lower bounds for different lengths of time since the onset of the Great Recession. For example, the US Federal Reserve lowered its target for the Federal Funds Rate to 25 basis points in December 2008, raising it to 50 basis points only in December 2015.

We suggest that the Bank of Canada should consider using quantitative easing to affect spending by acting permanently to expand the size of the money stock.[1] As noted earlier, QE involves open-market purchases of government securities and other financial assets from banks or elsewhere in the private sector. When the Bank buys securities from banks, it increases the cash balances these banks hold there, thereby expanding the Bank's balance sheet. Banks can use these balances to expand lending, which expands deposits held by their customers and thereby expands broader measures of the money supply. Since banks are no longer required to hold reserves with the Bank of Canada, they do not strictly need an increase in settlement balances in order to be able to expand their loans. However, settlement balances increase their holdings of liquid assets

1 There is a tradition in publications by the C.D. Howe Institute going back (at least) to Laidler and Robson (1991) of encouraging the Bank of Canada to pay more attention to monetary aggregates in the analysis and conduct of monetary policy, but this has had very little currency at the Bank or at other major central banks. The following is a non-exhaustive list of C.D. Howe Institute studies, or studies by scholars associated with the Institute, on the importance of money for monetary policy: Bergevin and Laidler (2010); Dubrovinsky (2014); Laidler (1999a, 1999b, 2004, 2007, 2012a, 2012b); Laidler and Robson (1991, 1993, 1995); and Siklos (2010).

and give them room and an incentive to add (more illiquid) loans to the asset side of their balance sheets.

Purchases of securities from the private sector expand bank deposits and broad money directly. These, in turn, encourage increased spending on goods and services without the Bank necessarily having to lower the overnight rate.

Conventional Monetary Policy

As we have discussed, during this inflation-targeting era, "conventional" monetary policy has come to mean influencing a short-term nominal interest rate in order to influence other market interest rates at short and longer horizons, and thereby influence spending. By altering spending, the amount of slack in the economy (as measured by the output gap) is affected, which puts upward or downward pressure on the rate of inflation. This is the Bank of Canada's own view of how its monetary policy works – see Bank of Canada (2012b), which also outlines three other channels for the transmission of monetary policy that interact directly or indirectly with the first: the prices of various assets such as bonds, stocks and houses, the exchange rate and expectations of future interest rates, inflation and growth.

The Bank's description (on its website) of how its monetary policy works assigns no role at all to monetary aggregates, although a Bank technical report by Longworth (2003) briefly mentions them. Longworth starts off by outlining the standard four-equation approach to monetary policy, and notes: "A fifth equation, a money-demand function, could be added to the model, but its only purpose would be to determine the stock of money, because money itself plays no role in the above equations" (Longworth 2003, 4). In a brief section on money and its effects, Longworth states three possible channels: a real balance effect if part of money is net wealth, a second real balance channel if real balances directly affect utility and "disequilibrium effects, which arise if there is a buffer-stock role for money" (Longworth 2003, 4). On the latter, he writes:

> The third channel, the buffer-stock role, has received much more attention in Canada, particularly because of the research done by Laidler and Robson (1995): see also Laidler (1999a, 1999b). These authors concentrate on the dynamic process that occurs when interest rates are lowered, credit is created as banks grant loans, and the proceeds from the loans are placed in the borrowers' transaction accounts. This could create a gap between the public's actual and desired holdings of narrow money, which in turn could cause an increase in spending. The proponents of this view admit that whether these events will indeed occur in this fashion is an empirical matter, but they point to the leading information in M1 for output and perhaps inflation as an indication that the buffer-stock role may be empirically important in Canada. (Longworth 2003, 5)

Unconventional Monetary Policy

"Conventional" monetary policy – that is, using changes in the overnight rate target in such a way as to affect the economy and have it return to full-employment output and a 2 percent inflation target over a six-to-eight quarter period – was in place at the beginning of period we cover. Since the Great Recession, however, "unconventional" monetary policy has grown in importance, and arguably has been the most significant change to the Bank of Canada's operations and thinking since 2002. We mentioned the primary unconventional tools in the previous chapter; here, we introduce our outline for how to use quantitative easing most effectively, which might become increasingly necessary the longer Canada is stuck in a low-interest-rate, low-inflation environment.

Providing Stimulus through QE

The first approach when using QE to provide stimulus is the use of classic open-market operations; the purchase of government securities from the banking sector. Banks acquire deposits from the Bank of Canada, and under normal circumstances will have an incentive to expand their lending activity, leading to an increase in deposits and therefore to an increase in broader measures of the money supply.

As mentioned earlier, until 2009 the Bank of Canada had a target of $25 million for daily settlement balances. This was increased to $3 billion in April 2009 as a result of the financial crisis (Zorn, Wilkins, and Engert 2009, 10). Subsequent to 9/11 and again after the Lehman Brothers bankruptcy in 2008, the Bank did provide liquidity to the financial system by purchasing securities, but these were purchased under repo agreements rather than outright.[2]

In situations where the Bank's overnight target rate and other short-term interest rates are very low, banks could have little incentive to expand their loans, and short-term assets become almost perfect substitutes for currency. A number of economists have called this situation a "liquidity trap," alluding to Keynes's use of the term in a different context. Congdon (2010, 2011a, 2011b, 2012) refers to a situation of low short-term interest rates as a "narrow" liquidity trap, as opposed to Keynesian "broad" liquidity traps in which individuals cannot be persuaded to buy longer-term securities because they fear a capital loss would ensue from an expected increase in longer-term rates of return.

Nevertheless, if banks do not have an incentive to lend and expand deposits, it would be difficult for the Bank of Canada to expand broader measures of the money supply – including various types of deposits with chartered banks by the private sector – by the use of classic open-market operations. Instead, the Bank can expand

2 Recall that, under repo agreements, the Bank buys securities from dealers who have agreed to repurchase them. On the liabilities side of its balance sheet, it was federal government deposits, rather than deposits of banks, that increased substantially after the Lehman Brothers bankruptcy; see Gordon (2009).

broad money directly by purchasing assets from the private sector. Private sector holdings of securities decrease, while deposits with the banking system (counted as part of broad money) increase. By buying up assets that are relatively illiquid, the Bank can influence the liquidity of households' and firms' portfolios. As long as they have a relatively stable preference for the ratio of liquid to total assets in their portfolios, households and firms will run down their liquid assets by bidding up the prices of less liquid assets or by purchasing goods and services directly.[3]

The question is whether these private investors are more likely to substitute one form of security for another or spend on goods and services. From the perspective of nominal spending and the price level, the latter has a much different effect than the former. In the end, what is likely to matter is a combination of liquidity needs on the part of consumers, as well as money as net wealth when judged against the expected repricing of securities. If we assume the latter to be true – and that banks do not increase lending from their newly acquired deposits – although individual households and firms can bring their own portfolios into balance, in aggregate the only way this can happen is for either nominal spending or the price level to increase, bringing the demand for broad money in line with the increased supply. This process is just the "musical chairs" or "hot potato" model of the effects of an increase in the money supply, familiar from the monetarist literature on the effects of monetary policy, combined with the buffer-stock approach alluded to above in the quote from Longworth (2003). The buffer-stock approach holds that individuals will temporarily absorb an increase in their holding of money for precautionary purposes, and bring their long-

3 The stability of the ratio of liquid to total assets is an empirical matter, and holds more closely for broader measures of money and for Divisia, or weighted, monetary aggregates, as opposed to simple-sum aggregates (see Belongia and Ireland 2012, 2015).

run demand for money in line with their holding of money by altering their spending patterns – see Laidler (1984) for a detailed description of this theory. At the end of the day, if households and firms maintain a stable ratio of liquid to total assets, this "hot potato" model could increase spending without forcing a lowering of interest rates.

What evidence is there that such a mechanism is important? First, note that QE, as practised by, for example, the US Federal Reserve, the Bank of England, the Bank of Japan and the European Central Bank in the aftermath of the financial crisis, was not in general very effective due to the prevailing "credit channel" view of how QE operates.[4] As we have discussed, this view holds that QE operates via two main mechanisms. First, QE can provide liquidity to markets where liquidity is in short supply due to a financial crisis – examples include the drying up of the interbank loan market in the United States and the ABCP market in Canada. Second, by purchasing longer-term securities, a central bank can drive up their price and lower their yield. This drives down the longer-term yield curve, and can help stimulate spending. Unfortunately, as we mentioned, empirical work finds only small quantitative effects on the yield curve, often measured in tens of basis points rather than in percentage points (see, for example, Swanson and Williams 2014).

For QE to be effective, money must provide benefits beyond its pecuniary rate of return, as Buiter (2014) notes. This is necessary

4 The Bank of Canada's own description of the effects of QE is similar to that of much of the modern literature – see, for example, Santor and Suchanek (2013); Reza, Santor, and Suchanek (2015). For details on how QE was implemented in the eurozone, Japan, the United Kingdom and the United States, see Fawley and Neely (2013). Selgin (2017) has also showed that QE's lack of success, as practised by the Fed, was a result of the decision to pay interest on reserves, which forces the Fed to pay a rate that is competitive with other market rates. This constrains the Fed as to how low it can reduce its policy rate. Selgin argues that such a constraint creates a deflationary bias, and is responsible for the Fed's continuously missing its inflation target since announcing a formal one in 2012.

so that people continue to hold money whose rate of return is dominated by non-monetary assets with a positive nominal interest rate.[5] There is abundant evidence in the literature that, for an open-market operation to have a strong effect on inflationary expectations and aggregate demand, it must be very persistent, if not permanent. QE, as practised by central banks since the financial crisis, for the most part has been explicitly designed to be temporary. In some cases, central bank purchases of securities had no net effect on their balance sheets because of offsetting open-market operations. Indeed, Beckworth (2014) argues that, in the United States, QE has had a limited effect on broad measures of money and on nominal income because it is expected to be temporary.[6] Woodford notes: "Under quantitative easing, people might not expect the increase in the monetary base to be permanent – after all, it was not in the case of Japan's quantitative easing policy in the period 2001–2006, and US and UK policymakers insist that the expansions of those banks' balance sheets won't be permanent, either – and in that case, there is no reason for demand to increase" (Reichlin, Turner, and Woodford 2013).

Effective use of QE, then, requires a central bank to establish credibly some sort of firm end point for the level of a nominal aggregate, which could be the level of nominal income or the future level or path of the price level.[7] The monetarist argument for QE is that, by influencing the size of a suitable monetary aggregate, a

5 Buiter (2014, 1) notes that, in a cashless economy, "in which something called 'money' serves as a numéraire but either has no existence as a store of value (currency, an account with the Central Bank or e-money) or yields no non-pecuniary benefits," QE cannot be effective. Such cashless economies are, not surprisingly, also the mainstay of today's central bank forecasting models.

6 Ambler (2016), in a standard New Keynesian model with a genuine role for money, shows that temporary QE has limited effects on inflation and real activity. See also Rowe (2016) on the importance of permanence.

7 This buttresses the argument for level targeting of some kind.

central bank can influence the volume of nominal spending in the economy. This is just a consequence of the proposition of long-run monetary neutrality.[8] Although monetarism has fallen into some disfavour among macroeconomists, the long-run monetary neutrality proposition still enjoys a broad consensus.[9] QE can also affect inflation expectations in the longer term, which has the effect of lowering *ex ante* real interest rates and stimulating spending. QE is often thought of as requiring coordination between the central bank and the fiscal authorities, a policy often called "helicopter drops" of money. The technical distinctions between QE and helicopter drops are reviewed in Box 3.

Conclusion

Increases in the money supply can have powerful real effects even at very low interest rates, as Congdon (2011b), Laidler (2012a), Thornton (2014), and many others have discussed. The Bank of Canada should aim to provide monetary stimulus through open-market operations or direct purchase of securities from the private sector. This might require some rethinking of the way monetary policy is currently conducted. At present, base money consists almost entirely of notes and coins in circulation. The Bank conducts its operations so that settlement balances held by members of the Canadian Payments Associations net out to small positive amounts at the end of each trading day. During 2009, the Bank did allow for significant positive settlement balances through its PRA program –

8 The velocity of circulation might change in the long run, but the central bank, in principle, can react to such changes to attempt to keep nominal spending on a stable growth path. Secular and short-run changes in velocity contributed to monetary aggregates falling from favour as targets for central banks. This would argue, as we note, in favour of level targets such as a path for the price level or for nominal spending to make permanent increases in broad money stocks credible.

9 See Benati (2009) for empirical evidence, and Nelson (2008) on the long-run link between money growth and inflation.

Box 3: Quantitative Easing versus Helicopter Drops

There has been much confusion in the academic and popular literature concerning how QE and so-called helicopter drops of money are related. The latter are usually interpreted to mean a coordinated effort by a central bank and a treasury to inject money permanently into the economy. One possible mechanism – the one most commonly alluded to – is for the treasury to borrow money directly from the central bank and to send a rebate to households, which deposit their rebate cheques in their bank accounts, thereby increasing broad money. Explicit coordination between the treasury and the central bank is required, and the balance sheet of the treasury is directly affected by such a series of transactions.

If the central bank purchases treasury securities from the private sector, the balance sheet of the treasury seems to be unaffected, but its intertemporal budget constraint (decisions for the present and future) is affected. The treasury has to pay interest on the securities to the central bank, rather than to the private sector, and the central bank remits these payments back to the treasury as part of its operating profits. Insofar as the central bank's injection of money is permanent, the treasury will be able to increase its spending or reduce taxation at some point. The central bank's action, therefore, does have fiscal consequences, but explicit coordination between the central bank and the treasury is not required for the central bank to expand the broad money supply.*

* Cohen-Setton (2015) develops in greater detail the argument for the equivalence of QE and helicopter money. For a critical view of helicopter money, see Borio, Disyatat, and Zabai (2016).

essentially acquiring assets via longer-term repurchase agreements – but the objective of the program was to provide liquidity in the short term, not to expand the monetary base in the longer term.

The Bank's operating procedures – particularly the goal of achieving close to zero net settlement balances each day – seem almost designed to eliminate the possibility of permanent increases in the monetary base via open-market operations. The Bank should think carefully about how to adapt these operating procedures in an environment with a zero or negative overnight rate before it finds itself stuck there. Possible changes would include: re-instituting required reserves, setting the policy rate at the deposit rate, and indexing the level of settlement balances to the price level. The Bank should also devote some resources, after what has been a long hiatus, to looking at the informational content and economic significance of monetary aggregates – something we showed to be worthwhile in Chapter 3.

Chapter 9

The Oil Price Shock of 2014–15

As we have detailed, in Canada the period from 2012 to 2014 was marked by a slow economic recovery from the earlier financial crisis. In late 2014, however, the recovery, though anemic, was rocked by a plunge in the world price of crude oil that was the most abrupt change since the drop from over $140 per barrel to less than $40 in the second half of 2008 as the world economy entered the Great Recession. The oil price shock flattened the growth of the Canadian economy, lowering the value of the output of Canada's petroleum industry, reducing investment expenditure in the petroleum sector itself and reducing demand for intermediate inputs into petroleum production. It also had cascading adverse effects on other sectors and industries, and real GDP fell in the first and second quarters of 2015. The Bank of Canada surprised markets with a 25 basis point rate cut in January 2015, announced as a measure "to provide insurance" against the downside risk to inflation and increased risks to financial stability caused by the drop in the price of oil (Bank of Canada 2015a). Continuing economic weakness led the Bank to cut its rate by another 25 basis points in July 2015, a move that the markets then widely anticipated.

The best monetary policy response to an oil price shock is a complex matter because of the many interactions between the petroleum sector and other sectors of the economy.[1] That said, there is a strong consensus in modern macroeconomic theory that the best monetary policy can do is bring the economy as close as possible to the equilibrium that would occur if all prices and wages were perfectly flexible, adjusting immediately to changes in market conditions. Thus, policy should strive to offset as much as possible the effects of nominal price and wage rigidities.[2]

The first step in developing the appropriate monetary policy response to an oil price shock would be for the Bank of Canada to calculate in detail the effects of the shock on employment, output, relative prices and the sectoral allocation of resources in the absence of nominal rigidities. The Bank has the ideal tool to calculate these effects: its ToTEM II forecasting model. Improvements are always possible, and we would be content if the Bank used its main forecasting tools more explicitly in explaining its response to oil price shocks. The main elements of this strategy should be the following:

- the Bank should use its global economic model (BofC-GEM) to forecast consistently the evolution of the world oil price and world GDP;
- The Bank should use its main forecasting and policy analysis model, ToTEM II, to forecast the evolution of the Canadian economy under the counterfactual assumption of flexible wages and prices; and
- the Bank should use these forecasts more explicitly as part of its communications strategy, in particular to explain how monetary policy is offsetting the effects of nominal price and wage rigidities.

Let us review the underlying issues and suggestions in more detail.

1 For a theoretical analysis of optimal monetary policy for an oil-producing economy, see Romero (2008).

2 See King and Wolman (1999) and Woodford (2003). Real distortions such as those due to imperfect competition are best left to other policy instruments such as taxes and subsidies.

The Qualitative Effects of an Oil Price Shock on General Equilibrium

Taking the world price of oil as given, the effects of a persistent oil price shock on the Canadian economy can be summarized as follows (we note in advance that the difficulty for any central bank is that many of these behavioural responses work in opposite directions).

- *A fall in potential GDP*: a reduction in the price of oil leads to a fall in the real value of output produced in the petroleum sector and to a fall in the quantity of petroleum produced as marginal wells are shut and fewer new wells are brought online.
- *Reduced real incomes*: falling potential GDP leads to reduced incomes for workers and owners of capital in the petroleum sector. Real income declines relative to the standard measure of real GDP. This might affect aggregate demand, with a negative effect even on the demand for domestically produced goods.
- *Currency depreciation*: since Canada is a net exporter of oil, a negative oil price shock depreciates the currency, which constitutes a fall in Canada's terms of trade, as a given quantity of exports buys fewer imports. The currency depreciation boosts demand for non-oil exports. The response of demand for these exports to a weaker currency is higher in the medium to long run, and it might take time for export industries to increase their productive capacity after a period of higher oil prices during which capacity shrank. Currency depreciation mitigates the drop in the price of oil, which is fixed on world markets in US dollars.
- *Increased demand for domestic products*: domestic suppliers of inputs to producers of tradable goods and services benefit from the increased demand for Canadian exports and reduced demand for imports.
- *Reallocation of inputs*: both capital and labour flow from the oil-producing sector to other productive sectors in the economy, but the reallocation is not instantaneous. To the extent that labour reallocation is costly, relative wages might have to fall in the

petroleum sector relative to the rest of the economy to encourage this reallocation and to equilibrate labour markets in all sectors during the adjustment process.

- *Loss of skills*: workers who leave the petroleum sector and look for work elsewhere suffer a loss of sector-specific human capital. As they enter other sectors of the economy, the marginal product of labour in those sectors falls in the short run. As a result, overall measured labour productivity falls.
- *Reduced investment demand by the petroleum sector*: the reallocation of capital means a drop in demand for equipment by the petroleum sector.
- *Lower prices at the pump and for other industries*: the reduction in the price of oil is of direct benefit to consumers of petroleum products, freeing up income to spend on other consumer goods (both domestic and imported). Other sectors also benefit from a drop in the prices of oil and oil products used as intermediate inputs.
- *Lower demand for goods and services by the petroleum sector*: on the other hand, to the extent that output from other sectors is used as an intermediate input by the petroleum sector itself, demand for the products of these sectors drops.
- *Lower inflation*: the drop in the price of oil has a direct effect on headline inflation – a level effect on prices, rather than on the rate of change of prices, and a change in a relative price that is determined in world markets. Currency depreciation offsets this effect to some degree as the price of imported goods increases.

As mentioned, these qualitative effects often push in opposite directions. The net quantitative effects of an oil price shock depend on many factors, including the responses of supply and demand to price changes, the relative importance of the oil sector in the economy and the strength of flows of goods and services between the oil sector and other productive sectors of the economy. Supply and demand responses can vary over time, and the pace of reallocation of capital and labour across sectors is gradual. World demand for non-petroleum exports depends on the evolution of world output.

Predicting this demand hinges on identifying the underlying causes of the change in the price of oil.

The last point is critical. The effects of a price change will always depend on the underlying cause and whether the change results from a shift in the supply curve for oil or in the demand curve. A drop in price that is principally demand driven typically is a sign of slowing world economic growth. In turn, this would affect strongly the degree to which the demand for Canadian non-petroleum exports could take up the slack from the reduced income from petroleum exports. A drop in price that is caused primarily by increased supply from past infrastructure investments coming on line (or from improvements to the technology of oil extraction) is much more positive for the world economy and would help the change in demand from petroleum towards other Canadian exports.

The consensus among published assessments of this issue, including by Bank of Canada researchers (Baumeister and Kilian 2015; Hamilton 2015), seems to be that the 2014–15 drop in oil prices can be explained in large part (but not entirely[3]) by an unexpected slowdown in worldwide economic growth. This tends to support the Bank's surprising decision to lower the overnight rate in January 2015. If lower demand was the cause of the oil price correction, the offsetting positive effects due to increased export demand could be weak, without additional stimulus from the Bank. We note, though, that the projected growth of the US economy, Canada's largest trading partner, often ends up being the determining factor.

3 The part of the oil price movement that was not demand driven came from two main sources. First, additional US supply, primarily shale oil, came online. Second, a price war broke out late in 2014 among OPEC producers, with Saudi Arabia no longer willing to restrict supply to maintain prices.

The Bank of Canada's Tools

The Bank of Canada is aware of these complex interactions, and has acknowledged them in its discussions of the effects of the oil price shock (see *Monetary Policy Report*, January 2015, April 2015, July 2015, October 2015, January 2016; Duguay 2006; Lane 2015; Mendes 2015; and Patterson 2016, among others). Its public discussion of the interactions, however, has been largely qualitative.[4]

The Bank has a rich set of formal tools with which to analyze the effects of an oil price shock on the Canadian economy and to simulate the effects of its monetary policy changes. Its main tool for forecasting the Canadian economy is the ToTEM II model (see Dorich et al. 2013), while its tool for analyzing global economic issues is the BoC-GEM, both of which we have discussed in previous chapters, and we do not repeat their definitions here. The question, then, is whether there are additional, useful ways in which the Bank could use these tools to inform policy and communicate its thinking to the public on matters as important to the Canadian economy as the resources sector.

Use a Model-based Estimate of Potential Output

As noted above, an oil price shock leads to changes in the equilibrium allocation of labour and capital across sectors. ToTEM II itself could be used to calculate this allocation. To do this would require the Bank to replace the model's equations for the slow adjustment of wages and prices with conditions that equate supply and demand in all labour and goods markets (complete wage and price flexibility). To our knowledge, a solution to the version of the

4 The Bank's January 2015 *Monetary Policy Report* contains a detailed forecast of oil prices, but does not outline the assumptions behind these projections in terms of supply versus demand factors.

model with flexible prices and wages is not an integral part of the Bank's internal forecasting and policy analysis.

Solving for and reporting ToTEM II's flexible-price equilibrium would convey an important advantage. It would generate a model-based estimate and forecast for potential output – the level of output that would prevail if wages and prices were able to adjust freely.[5] Potential output then could be used to calculate the output gap. Rather than using its main forecasting model to calculate potential output and the output gap, however, the Bank currently uses statistical methods that could lead to inconsistencies with respect to each other and with respect to the implications of ToTEM II.

The Bank offers two different measures of the output gap – "statistical" and "structural," equivalent to the "extended" and "integrated" frameworks – in its *Monetary Policy Report*. Both measures involve smoothing out abrupt changes in either output itself (the statistical measure) or in labour inputs and labour productivity (the structural measure). By ruling out abrupt changes by construction, the measures cannot allow for short-run changes in the labour supply due to income or substitution effects or for abrupt fluctuations in either labour productivity or total factor productivity. Oil price shocks act in many ways like productivity shocks. They can therefore affect potential output abruptly in ways that look like productivity shocks – as noted above, they also affect potential output by causing a reallocation of inputs across different sectors of the economy.

5 Justiniano and Primiceri (2008), among others, distinguish between natural output, the level that would prevail under flexible prices and wages but in the presence of monopoly distortions, and potential output, which would prevail with flexible wages and prices but also with monopoly distortions removed. We ignore this distinction here. As we noted in the introduction, the consensus in the literature on optimal monetary policy is that it should offset as much as possible the distortions from nominal rigidities. Correcting the distortions due to monopoly power is best left for other instruments, such as taxes and subsidies.

The Bank thereby might underestimate short-term fluctuations in potential output and overstate the size of fluctuations in the output gap. Both measures potentially overstate the size of the output gap because they cannot capture the abrupt effect of an oil price drop on potential output. This could cause the Bank to overestimate the need to cut its target for the overnight rate and to offer too pessimistic a view of the medium-term pressure on inflation in its communications with the public.

Calculate the Flexible-Price Equilibrium Path of Output

The Bank could also use ToTEM II to simulate a path for the economy while allowing for the complete flexibility of prices and wages. By calculating a path for the economy's flexible-price equilibrium, the Bank would be able to calculate and report how changes in its monetary policy would affect the distance between the economy's equilibrium and its flexible-price equilibrium. This would include a time path for the output gap that is completely consistent with the model-based estimate of potential output discussed in the previous subsection.

Given the complexity of ToTEM II, the divergence of the economy's equilibrium path with and without flexible prices and wages necessarily would be multidimensional. The projected degree of labour market slack typically would differ between the commodity-producing sector and the rest of the economy, and the pressure on output prices could also differ across sectors.

Use Conditional Projections from the Models for Communication

Although there are additional costs to producing and publishing detailed forecasts, we believe they are outweighed by the benefits. Our recommendations for improving the Bank's communications thus would include the following elements:

- report the assumptions behind the BoC-GEM forecast of world oil prices and of world GDP along with the forecasts themselves;
- report conditional forecasts for GDP, sectoral outputs and employment, and report sectoral output prices conditional on the projected time paths of oil prices and world GDP generated by BoC-GEM and also conditional on the Bank's monetary policy;[6]
- report conditional forecasts for the paths of flexible-price GDP, sectoral output and employment.
- publish a conditional path for the overnight rate target, since the projected paths of GDP and sectoral employment, output and the capital stock all would be contingent on the projected path of the interest rate;
- explain how the projected path of the policy rate is helping to move the economy towards its equilibrium path with flexible prices and wages; and
- because of the complex interactions between the gas and petroleum sector and the rest of the economy, it is possible that monetary policy will involve short-run tradeoffs between moving one or more sectors of the economy closer to their flexible-price equilibrium paths while moving other sectors farther away from this ultimate goal.

In many ways, our communications recommendations related to the oil price shock could be extended to monetary policy in general. We then would add that the Bank could publish its forecasts as part of, or as an annex to, the quarterly *Monetary Policy Report*. The Bank thereby could put its quantitative models in the public domain, allowing academics and private sector analysts to run their own scenarios and facilitating dialogue with professional practitioners.

We believe our recommendations would increase the transparency and predictability of the Bank's monetary policy. As Melino and Parkin (2010, 1) have also advocated, "[m]ore accurate forecasts of the Bank's future policy choices lead to better

6 These forecasts could potentially be modified by staff judgment and/or Governing Council.

financial decisions, better price and wage-setting decisions, and the attainment of low and stable inflation with minimum disturbance to the real economy." Such forecasts should also increase the effect of the Bank's policy announcements on demand and output. That is, they should reinforce the transmission mechanism of monetary policy by affecting individuals' expectations of the interest rate over longer horizons – expectations that are important for expenditure decisions such as investment and the purchase of consumer durables. Announcing a policy rate without a conditional path for future rates could have negligible macroeconomic effects if it did not also influence expectations of those rates; more clarity about the future path of the policy rate would reduce uncertainty about that path and reduce the divergence of inflation expectations across individuals.[7] These changes would improve the predictability and transparency of the Bank's monetary policy overall, not just in response to major oil price shocks.

Use Judgment

As many authors have pointed out, no central bank is likely to choose a path for its policy rate based entirely on a mechanical rule. Models are necessarily simplifications of reality. The shocks that hit the Canadian economy are more complex than can be accounted for in a model like ToTEM II.[8] The interest rate decisions made

7 For an elaboration of this point, see Clinton et al. (2015). The central banks of Norway and Sweden have been publishing conditional policy rate forecasts since 2007 and 2005, respectively. New Zealand's Reserve Bank publishes forecasts of a short-term market interest rate, but not of its own policy rate. For a summary of differing views on the usefulness of publishing conditional policy rate forecasts and an empirical assessment, see Beechey and Österholm (2014).

8 It might also be the case that ToTEM II, developed and estimated for a period of higher average interest rates, is not coping well with the current low-interest-rate environment.

by the Bank of Canada's Governing Council are often based on more recent information that has become available after the last forecast generated by the quarterly ToTEM II model. Moreover, the decisions often reflect judgments by Bank staff and Governing Council members based on information that is not part of the Bank's forecasting models. As Melino and Parkin (2010) note, the forecasts of inflation and output that appear in the Bank's *Monetary Policy Report* do not necessarily coincide with those generated by ToTEM II. This is understandable and normal, but it should also be part of the Bank's communications. By publishing both the Governing Council's final forecasts and the forecasts generated by the model, the Bank can explain the divergences between the two – in particular, the information that led to the divergence. This would help to make the Bank's interest rate path more predictable and transparent.

The task of explaining the general-equilibrium effects of oil price shocks – or, for that matter, any other kinds of shocks – would not be an easy one, but it would be worth the effort. As Cateau and Murchison (2010, 27) note, "it is in the central bank's own best interest to respond to economic developments in a predictable fashion that is easy to communicate. Not only does this facilitate a better understanding of current policy actions, but it permits markets to better forecast the central bank's future actions."

Conclusion

The past responses of central banks to major oil price shocks illustrate how difficult it can be to get the policy mix correct, and the high cost of making mistakes. The Great Inflation of the 1970s in the United States and Canada can be blamed largely on inappropriate accommodation of the two major oil price rises at the beginning and the end of that decade. The monetarist interpretation of the Great Recession similarly emphasizes the inappropriate response of the US Federal Reserve to the oil price increases of late 2007 and early 2008.[9] The Bank of Canada already recognizes that responding to real shocks such as those of oil prices is much more difficult than stabilizing aggregate demand (*Monetary Policy Report*, January 2015; Poloz 2015). Building on this recognition, the use of formal tools as a more integral part of its communications strategy would increase the transparency and predictability of the Bank's monetary policy. In turn, this would increase the effectiveness of policy, and that could only be a good thing.

9 Hetzel (2009, 20) writes: "[I]n late spring 2008, central banks became increasingly concerned that persistent headline inflation in excess of core inflation would destabilize expected inflation and compromise their inflation objectives…As evidenced by the intensification of recession in summer 2008, central banks caused declines in the real interest rate to lag behind declines in the natural interest rate."

Chapter 10

The 2016 Renewal of the Inflation-Control Agreement

Another significant event in the period covered by this book was the 2016 renewal of the inflation-control agreement. It was significant not because of its surprising nature or its economic consequences, but because many of the research questions the Bank of Canada itself highlighted leading up to the renewal are the focus of enquiry in economics and monetary policy these days. In this chapter, we highlight how the Bank responded to these questions, and offer some suggestions as to how they should be handled going forward.

To reiterate, Canada has had an inflation-targeting regime since 1991, with a target of 2 percent since 1995 and a control range of 1 to 3 percent. The Bank of Canada periodically renews its agreement with the federal government concerning the inflation-control target – most recently at the end of 2016. Since 1996, the main components of this inflation-control target have remained the same. A substantial part of the Bank's research agenda is devoted to analyzing how well its monetary policy framework is performing and whether it should be either tweaked or modified substantially. The renewals of the inflation-control agreement focus on whether the Bank's objective and mandate remain appropriate and what changes (big or small) are required. In a 2014 speech, Deputy Governor Agathe Côté (2014) summarized the three main questions the Bank would look at in the run-up to the 2016 renewal:

- should the targeted rate of inflation be raised above 2 percent?
- how should considerations of financial stability be integrated with monetary policy?
- what should the Bank use as its measure of core inflation?

After analyzing the period between the 2011 and 2016 renewals, the Bank concluded that the benefits of a higher inflation target, including principally reducing the episodes of being constrained at the effective lower bound, were outweighed by the costs, in terms of both the redistribution of wealth and the Banks' own loss of credibility. We agree with this perspective, as we will explain below; we will also explain why the Bank should consider modifications to the monetary policy framework up to and including some form of level targeting.

The Bank also argued that, although it always takes financial stability concerns into consideration in its monetary policy decisions, the objective of financial stability is best met using financial regulation and supervision that includes appropriate microprudential and macroprudential tools. We again concur with this view, and expand on the theory underpinning the decision. We do, however, believe there are areas where the Bank could go further, including refining and expanding its guidelines for liquidity provision in times of crisis and seeking simple heuristic approaches to promote financial stability. On liquidity provisions, we talk briefly about these issues here, with a further expansion in the next chapter.

Lastly, the Bank found that the CPIX – its core inflation measure – had become less useful as the operational guide for monetary policy. In searching for a replacement, the Bank acknowledged that, since monetary policy transmission works by affecting demand in such a way that inflation moves in a given direction, what is needed is a measure that both correlates highly with the output gap and is not sensitive to sector-specific movements. As a result, and given that not one measure met all the criteria the Bank considered (laid out nicely in Bank of Canada 2016b), the decision was made to replace CPIX with a measure of core inflation that tracks common price changes across categories in the CPI basket (CPI-common), a measure of inflation excluding upside and downside outliers (CPI-trim), and the median inflation rate across CPI components (CPI-median). Although we support improvements in the core measure itself, what was missing from the discussion at the renewal was that any measure of core inflation, while useful as an operational guide, should not in itself be a good predictor of headline inflation. We expand on this line of thinking below.

A Change in the Targeted Rate

Before the 2008–09 Great Recession, the Bank of Canada was seriously considering lowering the inflation target below 2 percent. This would have been a move toward true price stability, and might have reduced the economic costs associated with inflation (Ambler 2008). The context was a period during which the Bank was, on average, successful in hitting its inflation target and fluctuations in output were relatively mild. Between the beginning of 1996 (around the time inflation dipped below 2 percent) and the end of 2006 (just after the 2006 renewal), inflation averaged 2.03 percent.

The financial crisis of 2007–08 and the onset of the Great Recession led the Bank of Canada, along with many other major central banks, to lower its policy rate to its assumed lower bound. Despite entertaining the possibility of a negative overnight rate (Poloz 2015b), there are still limits, however, on how low a central bank's policy rate can go before banks and other firms and individuals switch to holding cash, which yields a nominal interest rate of zero – except for the insurance and storage costs involved in holding it (see Witmer and Yang 2016). Once the lower bound has been reached, there is no room left for conventional monetary policy to be more expansionary. Moreover, many central banks, including Canada's, have been systematically undershooting their inflation targets. In Canada, inflation averaged 1.88 percent from the beginning of

2007 to the end of 2011, just after the announcement of the 2011 renewal of the inflation-control agreement, and 1.37 percent from the beginning of 2012 until the end of 2016, while real output remained significantly below its pre-2008 trend level.[1]

Analysts and central banks largely failed to anticipate the financial crisis that triggered the Great Recession. Policies are now being considered to prevent a recurrence of the crisis, but most central banks have revised upwards their evaluation of the probability that their policy rates will hit the zero lower bound. It also seems likely that the long-run neutral rate in Canada (and elsewhere) is lower because of slower real growth and demographic factors (see Ambler and Alexander 2015; Wilkins 2014). If so, some research— such as that of Blanchard, Dell'Ariccia, and Mauro (2010) and Bayoumi et al. (2014) – suggests that a higher inflation target could be beneficial by reducing the probability that a negative shock will push policy rates to their lower bound. The Bank of Canada was correct, however, to resist the temptation, for a number of reasons.[2]

Distributional Consequences and Loss of Credibility

First, an increase in the targeted rate of inflation would have caused a transfer of wealth from creditors and savers to debtors. Holders of bonds with principals fixed in nominal terms would have suffered capital losses. It would also have reduced the wealth of individuals whose incomes are fixed in nominal terms and

1 There are many possible explanations for this, including a weak global recovery from the Great Recession, weak energy price inflation, continued slack in the Canadian economy and increased competition in the retail sector. See Macklem (2014) for a summary of the arguments and the evidence.

2 An additional argument for raising the inflation target is that it might alleviate the effects of possible downward nominal wage rigidity by reducing the frequency with which downward wage adjustment is necessary to foster labour market equilibrium; see Kryvtsov and Mendes (2015) for a summary of this argument.

not completely indexed to the cost of living. This is precisely the kind of unanticipated redistribution of wealth that the inflation-targeting regime was intended to avoid by making inflation more predictable. Had the inflation target been raised with little warning, it would have constituted a breach of trust, and could have seriously undermined the Bank of Canada's credibility. Under an inflation-targeting regime, individuals cannot predict future prices with certainty: shocks to inflation are not corrected, and therefore can have a permanent effect on the level of prices. In practice, however, Canada's inflation-targeting regime has kept average inflation very close to the 2 percent target since 1996, conferring a relatively high degree of predictability on future prices and reducing uncertainty for parties to contracts (such as almost all mortgages) whose payoffs are denominated in nominal terms.[3]

Additionally, even if the Bank of Canada had raised the targeted rate of inflation, it is not clear that expectations would have coalesced quickly (or at all) around the higher target. Markets could well have incorporated an expectation of further future increases in the target, which would have meant a loss of credibility by the Bank. In turn, this could have reduced the effectiveness of changes in the policy rate to influence aggregate demand and keep inflation on track. If inflation expectations had become unanchored from the target, future negative shocks might have required larger reductions in the overnight rate to move inflation back to the target. This would have defeated the purpose of moving the neutral rate of interest farther from the zero lower bound.

The Potential Welfare Costs of Even Moderate Trend Inflation

The second reason the Bank of Canada was correct to resist raising

3 As noted earlier, inflation has started to undershoot the target systematically since the Great Recession.

the inflation target is that, despite arguments by advocates of a higher target that inflation is not very costly in terms of economic welfare at moderate rates – say, two or three percentage points higher than Canada's 2 percent target – such an argument might be fragile to the type of economic model used to do the welfare calculations that led to its conclusion.

In a study of the US economy, Ascari, Phaneuf, and Sims (2015) extend the standard New Keynesian model in several plausible directions. First, their model includes wages (and not just prices) that adjust only slowly over time. Second, it embodies trend growth in neutral and investment-specific productivity. Third, it takes into account the roundabout nature of the production structure of advanced economies, with the outputs of most sectors being used as inputs by almost all other sectors. The authors calculate that an increase in trend inflation from 2 to 4 percent would lead to a total welfare loss equivalent to 6.9 percent of one year's average level of consumption. This is an order of magnitude higher than the welfare loss of higher inflation in models without these plausible modifications.[4] This suggests that moderate trend inflation might well be much more costly than previously thought. If, as Blanchard, Dell'Arricia, and Mauro (2010) argue, increasing the targeted rate decreases the frequency with which the policy rate is driven to its lower bound, there are potentially better alternatives. As we discuss below, level targeting is one alternative that makes hitting the lower bound less likely.

4 This includes the Bank of Canada's own principal forecasting model, ToTEM II, which takes account of the roundabout nature of production in a very limited way. For this reason, it would also understate the costs of moderate inflation in the Canadian economy. The authors' extensions are features of all advanced economies, including Canada's. Relying on the predictions of a simulated model can be justified by noting that no central bank that has adopted an explicit inflation target has subsequently increased the targeted rate of inflation.

Unconventional Monetary Policies at the Zero Lower Bound

Côté (2014) notes that the Bank of Canada is studying so-called unconventional monetary policies and how they can help the economy avoid or get out of zero-lower-bound situations. As we discussed in Chapter 8, these policies include things such as forward guidance and quantitative easing. Côté remarks: "[I]t is still unclear to what extent [unconventional monetary policies] can effectively substitute for conventional monetary policy." As the Bank of Canada has highlighted for future research (Bank of Canada 2016b) countries are beginning to stop using these policies, meaning their effectiveness is becoming a focus of study.

We discussed earlier how we would approach quantitative easing. It is also possible, however, that the most effective unconventional monetary policies involve level targeting of some kind. Price-level targeting means fixing a target path for the CPI itself (or another price index), which has been shown to lead, at least in the context of simulation models,[5] to greater stability of both inflation and real output. With lower inflation variability, the central bank's policy rate is less likely to be driven to its lower bound by an unfavourable shock. Also, if the policy rate is at the lower bound, inflation over the medium to long term will be expected to be equal to the targeted trend inflation rate, so that the real ex ante interest rate at those horizons will, in general, be more negative than under inflation targeting, thus providing more stimulus to the economy.[6] This

5 Empirical evidence on price-level targeting is limited, since it has only been tried for a period of a few years in Sweden in the 1930s; see Berg and Jonung (1999) for a detailed discussion.

6 See Amano and Ambler (2014) for a simulation study supporting these conclusions. They show that a price-level-targeting regime involves both fewer and shorter episodes at the zero lower bound; see also Amano and Shukayev (2010, 2012). Coibion, Gorodnichenko, and Wieland (2012) find that the optimal trend inflation rate under price-level targeting is closer to zero than under inflation targeting, and that moving from inflation targeting to price-level targeting yields substantial gains in economic welfare.

follows from simple arithmetic: for a given level of the nominal interest rate, a higher expected rate of inflation means a lower ex ante real interest rate.

Credibility is important. This means that any price-level targeting regime must be symmetric, which, in turn, means that correcting positive surprises to inflation is as important as correcting negative surprises. If the inflation surprise is due to a positive aggregate demand shock, a period of inflation that is lower than the target is compatible with reducing the size of the (positive) output gap. If it is due to a negative supply shock such as an increase in the price of oil, there is a strong argument that the central bank should not cause a decrease in demand to bring the overall CPI back to its target path. It should, in fact, target a price index other than the CPI, as we discuss below. Unfortunately, this might be difficult to communicate.

Indeed, this type of communications difficulty is the Bank of Canada's main objection to forms of level targeting. The Bank argues that such policies work well only if they are well understood by the public and if the public is able to forecast the effects of monetary policy under these changed regimes (see Côté 2014). We would point out, however, that the initial implementation of inflation targeting in 1991 was to a large extent a leap of faith. Its success depended on credibility and on rapid learning by individuals to allow for the convergence of medium-term inflation expectations with the target and a moderation of wage settlements in what had been, up to 1991, a high-inflation environment. The decrease in inflation between 1991 and 1996 was more rapid and less painful than some (including some at the Bank) had predicted.[7]

7 Amano, Engle-Warnick, and Shukayev (2011) present evidence from laboratory experiments showing that subjects adapt relatively quickly to a price-level-targeting regime, although they do not fully use the target-reverting nature of the price level when forecasting inflation.

The current context is different. Instead of looking for a regime that can bring high inflation under control, Canada and other advanced economies are currently looking for adjustments to monetary policy that will help fend off either outright deflation or inflation that is persistently below target. Many analysts attribute the stagnant growth of the world economy to the seeming inability of central banks to stimulate the growth of aggregate demand. This should serve to concentrate the minds of central bankers and encourage them to try innovative approaches such as level targeting. The economic costs of stagnant growth might well be comparable to the costs of high inflation in the 1980s, which led to the last major shift in the monetary policy frameworks central banks use.

Bernanke (2017) has suggested a hybrid regime between inflation targeting and price-level targeting. This would involve a commitment by the central bank to respond differently when its policy rate hits its effective lower bound. During normal times, the current inflation-targeting framework would guide decision-making, but if, and for as long as, the policy rate binds at the zero lower bound, the central bank would target the *average inflation rate* over this period. Such a policy would be tantamount to correcting negative inflation surprises when they are sufficient to drive the policy rate to its lower bound while letting bygones be bygones in response to positive inflation surprises. In other words, it would be equivalent to temporary price-level targeting that would apply only in episodes at the effective lower bound.

Bernanke (2017) also suggests that, if the central bank communicates in terms of average inflation rather than the price level, the public would understand its policy more easily. We are not fully convinced. The public would have to understand the distinction between an inflation target and an average inflation target, and also that the number of periods over which inflation is averaged is variable and extends as far back as the most recent effective-lower-bound episode. If credible and successful, such a monetary policy regime would also entail a long-run average inflation rate greater than the target rate because of its asymmetric nature. This could lead to cognitive dissonance that would undermine the central bank's credibility.

Simple Alternatives

Without going all the way to level targeting, simple alternatives are also available. One would be average-inflation targeting regardless of where the policy rate sits (see, for example, Nessén and Vestin 2005), under which, instead of targeting the rate of inflation itself, the central bank would target a moving average of past inflation rates. In fact, Canada's current inflation-targeting regime is already a form of average-inflation targeting. The Bank of Canada publishes inflation figures monthly, and defines headline inflation as year-on-year inflation, which is just the moving average of monthly inflation rates over the previous twelve months or four quarters. Our alternative would simply be an extension of the averaging period.

The main reason for adopting average-inflation targeting (over a longer period) is to ensure that the central bank corrects past deviations of inflation targeting to some extent. If inflation as measured by the moving average is lower than the targeted rate, then to bring the moving average back to target, monthly or quarterly inflation would have to move higher than the targeted rate in the short run. Correcting past deviations of inflation would mean that bygones would not be bygones, as they are under a pure inflation-targeting regime. The central bank's policy then would become history dependent, a hallmark not only of level targeting but also of policy under commitment in the sense of Kydland and Prescott (1977), and therefore a means of attaining a higher level of economic welfare (see also Dennis 2003; Dennis and Söderström 2006).

As the length of the moving average window increased, so would the amount by which the central bank would have to correct for past deviations of inflation from the target. In the limit, as the moving average became very long, an average-inflation-targeting regime would approach a price-level-targeting regime. Moving to two-year-on-two-year (or even longer) period[8] would move in the direction of price-level targeting with minimal changes to the policy framework. A longer moving average window would affect the speed with which the Bank aims to return inflation to target, which is currently within six to eight quarters. The optimal horizon would be longer. Finding the optimal horizon would be the most difficult challenge when moving to average-inflation targeting. At or close to the zero lower bound, it would have the advantage of increasing inflation expectations going forward, lowering real interest rates, and, thereby, stimulating aggregate demand.

The Bottom Line on the Inflation Target

The Bank of Canada was correct not to squander its hard-won credibility by increasing the target rate of inflation, especially since the costs of even moderate trend inflation (in the range of 3–4 percent) might be higher than previously estimated. Given worries about the zero lower bound, the Bank should consider alternative monetary policy frameworks, including some form of level targeting. The Bank could mitigate concerns about communications and how the public learns about a new policy framework through the same kind of quick adjustment the Bank used to introduce inflation targeting in 1991. Level targeting would also help Canada avoid falling into a low-inflation, low-output trap of the kind that has plagued Japan and that now might have infected the eurozone. If the Bank does not find the case for level targeting convincing, simple alternatives such as average-inflation targeting are available,

8 This would define the targeted inflation rate as the annualized rate of change of the price level over a 24-month period.

and would entail only small adjustments to the current monetary policy framework.

Financial Stability

In the 2016 inflation-control renewal agreement, the Bank of Canada acknowledged that monetary policy should be adjusted for financial stability concerns only in the most exceptional of circumstances. In fact, the Bank argues that, since the financial crisis, a set of tools has come to prominence better suited to deal with financial stability concerns. Examples include global financial reforms that analyze and prescribe capital and liquidity buffers meant to reduce financial sector vulnerabilities. Macroprudential tools and policies have also been tried, and we are now far enough into their implementation to be able to assess their effectiveness. This combination of regulatory reform and macroprudential regulation works together, through a prudential authority, to oversee and maintain financial stability. In this fashion, the tension between financial stability concerns and monetary policy has been reduced.

What is necessary, then, is a clear division of the policies and responsibilities between agencies in order to achieve simultaneously the goals of monetary policy and financial stability. Coordination becomes less of a concern if monetary policy is having a greater effect on inflation than financial stability concerns, and vice-versa for macroprudential regulation. The freedom for monetary policy to focus on inflation relies on prudential authorities' having the "will and policy tools to mitigate financial system vulnerabilities and increase resilience" (Bank of Canada 2016b, 30). We agree, and in this chapter we expand on how best to achieve this goal, a missing component of the 2016 renewal document (Bank of Canada 2016b).

As Côté (2014) notes, however, the integration of considerations of financial stability with monetary policy is "a work in progress," and in recent years many central banks' low-interest-rate policies have led to concerns about pressure building up in financial markets. The Bank of Canada itself (Bank of Canada 2016b) has noted that rising tensions between monetary policy and financial stability are more likely to rear their ugly head in a situation of persistently low interest rates – the exact scenario Canada and much of the developed world now faces.

How, then, should the Bank of Canada respond? We analyze four areas that financial stability should look to prevent or mitigate (see Buiter 2012): (1) liquidity crises for systemically important financial institutions and for the sovereign – that is, the central bank should act as lender of last resort; (2) market liquidity crises for systemically important instruments by the central bank's acting as market maker of last resort; (3) asset market and credit booms, bubbles and busts; and (4) solvency crises for systemically important financial institutions.

Lender and Market Maker of Last Resort

The first role of financial stability policy – to prevent or mitigate liquidity crises for systemically important financial institutions and for the central bank to act as lender of last resort – has been a traditional part of central banking since the nineteenth century, and should continue to be so.[9] Bagehot ([1873] 1999) is the standard source for how central banks should act as lenders of last resort; Humphrey (1989) summarizes Bagehot's principles as follows:[10]

9 Tucker (2015) argues that, even if liquidity should be given to financial institutions primarily by providing the market as a whole, a need will remain in limited cases for direct, bilateral assistance.

10 Much of what Bagehot wrote has been interpreted in different ways by different scholars. We rely on Humphrey's interpretations, which are not without controversy. See also Bordo (2014); Haltom and Lacker (2014, 2015); Hogan, Le, and Salter (2015); and Laidler (2003b) for further and possibly differing interpretations, and Mehrling (2011, 2014) for an analysis of how Bagehot's prescriptions can and should be modified to suit the current institutional context.

- protect the money stock instead of saving individual institutions;
- rescue only solvent institutions;
- let insolvent institutions default;
- charge penalty rates;
- require good collateral; and
- announce these conditions before a crisis so that the market knows exactly what to expect.

The second role of financial stability policy – for the central bank to act as market maker of last resort or, in the parlance of Mehrling (2014), dealer of last resort – is similar to that of the central bank as lender of last resort. This role, however, came fully into play only during the 2007–08 financial crisis, when the interbank market, involving both traditional and non-bank financial intermediaries, or "shadow banks" for short-term funding seized up completely. Rather than extend credit, a central bank as market maker of last resort purchases assets in markets where liquidity has dried up. Tucker (2015, 29) relates the two functions as follows: "[J]ust as by lending the [lender of last resort] can signal that the beneficiary(ies) is in fact OK, so by purchasing securities they could signal that fears about an asset class were misplaced." Tucker goes on to discuss how principles similar to Bagehot's can be applied to the role in this case.

During the financial crisis, the US Federal Reserve acted frequently as both lender and market maker of last resort, undertaking transactions involving both direct bilateral relationships with banks and other institutions and more market-based allocation mechanisms such as auctions. Cochrane (2009), Hummel (2011), Humphrey (2010), White (2010) and others have argued that Bagehot's principles have been honoured more in the breach than in the observance by central banks such as the Fed. They argue that the Fed has used its powers to allocate credit to specific sectors and institutions and to rescue insolvent financial institutions using the justification of systemic importance. In other words, the Fed has engaged in "credit policy," rather than in monetary policy. With these competing views in mind, how might central banks act so as to follow Bagehot's principles and still act as market maker of last resort when necessary?

Credit Policy

Acting as lender or market maker of last resort and mitigating solvency crises for systemically important institutions embodies the danger that central banks' responsibilities will be greatly enlarged and that they come to make decisions about the allocation of credit to individual sectors and individual financial firms.

The distinction between monetary and credit policy can be defined as follows (see, for the case of the US, Goodfriend 2014, 113): "Monetary policy refers to the expansion or contraction of currency or bank reserves via Fed purchases or sales of Treasury securities." It is true that even pure monetary policy has consequences for a government's budget constraints, since the central bank remits any profits (less its operating costs) from its holdings of treasury securities to the government. These consequences are relatively circumscribed, however, and by holding treasury securities in order to expand and contract the monetary base, the central bank avoids credit risk, at least insofar as the risk of sovereign default is zero or exceedingly low. In the US context, "[c]redit policy involves lending to financial institutions or the purchase of non-Treasury securities financed by selling Treasury securities" (113). Such actions involve taking on credit risk, and fall into the realm of fiscal policy. Goodfriend further says that, "[w]hen consolidated with the Treasury's balance sheet, Fed credit policy contributes loans and purchases of non-Treasury securities. Unlike monetary policy, Fed credit policy involves fiscal policy – lending to particular borrowers – financed by sales of Treasuries against future taxes" (113).

Fiscal policy is usually undertaken by elected officials who are accountable at least to the electorate. Making the Bank of Canada responsible for such decisions thus could lead to conflict with the Department of Finance and to increased scrutiny by the press and other outside critics of the Bank. In turn, this eventually could threaten the Bank's effective operational independence. Once more, with respect to the United States, Goodfriend (2014, 116) notes:

> A Fed credit policy decision that commits substantial taxpayer resources in support of the financial system or one that denies taxpayer resources is inherently a highly-charged, political, fiscal policy matter. Initiatives that extend the Fed's credit reach in scale, maturity, and eligible collateral to unsupervised or potentially insolvent institutions inevitably carry credit risk, excite questions of fairness, and potentially threaten conflict between the Fed and the fiscal authorities – with the potential to destabilize financial markets and employment. Worse, an ambiguous boundary of expansive Fed credit policy creates expectations of Fed accommodation in financial crises, which blunt the incentive of private entities to take preventive measures beforehand to shrink their counterparty risk and reliance on short-term finance, and build up financial capital.

The "expectations of Fed accommodation" amount to a problem of moral hazard. A bank that knows it is systemically important also knows that the central bank will intervene to mitigate any potential solvency crisis. This, in turn, will influence the kinds of risks the bank is willing to take on. Indeed, moral hazard was at the centre of the 2007–08 financial crisis (see Cochrane 2009; Haltom and Lacker 2014b; Humphrey 2010; Roberts 2010; White 2010).

The Bank of Canada's Intervention in Financial Markets

As described earlier, the Bank of Canada's intervention in financial markets during the 2008–09 crisis was relatively circumscribed. To provide liquidity to financial markets, the Bank set up its Term Purchase and Resale Agreement Facility to offer short-term collateralized funds to LVTS participants that were undergoing difficulties obtaining short-term financing in private markets. The program was initiated in December 2007 and was wound down in 2009. At the time, the Bank was acutely aware of the potential problems of taking on credit risk and creating moral hazard. To limit these concerns, the PRA Facility was based on auctions, which meant that credit was allocated via the market as a whole, rather than through direct bilateral relationships with financial institutions. Additionally, by allowing asset-backed commercial paper to be used as collateral when providing liquidity through the PRA Facility, the Bank helped unfreeze this market – although it did not itself make outright purchases of such commercial paper. To tie its own hands, the Bank laid down a specific set of guidelines for the use of the Term PRA Facility. Under these guidelines, first outlined in Engert, Selody, and Wilkins (2008), who indicate they were developed during the heat of the financial crisis, and summarized in Longworth (2010) and Selody and Wilkins (2010), intervention was to be:

- targeted at mitigating market failures of system-wide importance that a central bank could rectify by providing liquidity;
- graduated or commensurate with the severity of the problem;
- well designed and based as much as possible on market-based transactions via auctions, while loans could be used to address liquidity shortages affecting specific institutions;
- at market-determined prices to minimize distortions and to prevent the crowding out of market transactions by the central bank; and
- designed to limit potential problems of moral hazard by being limited, selective and at penalty rates as appropriate.

These guidelines show that the Bank was well aware of its own limitations and of the dangers of interfering with market equilibrium.[11] This is appropriate. The Bank should retain this set of principles to govern its intervention in financial markets and work on further refining the details.

Macroprudential Policy

The last two roles for financial stability policy – preventing or mitigating asset market and credit booms, bubbles and busts, and preventing or mitigating solvency crises for systemically important financial institutions – have come to be known as macroprudential policy.

The "macro" in macroprudential policy refers to the idea that financial stability policy deals with equilibrium in financial markets and how financial markets interact with the rest of the economy. Macroprudential policies can have a time-variant component (related to the business cycle) and can vary across different firms – for example, when some firms are of sufficient importance to systemic consequences for financial market equilibrium and the macroeconomy. The tool kit for macroprudential policy includes tools to address excessive credit expansion (countercyclical capital buffers, regulated loan-to-value ratios, debt-service-to-income ratios and so on), tools to limit excessive leverage (risk weights, limits on intra-financial sector exposures and so on) and tools to limit systemic spillovers (firm-specific capital and liquidity requirements based on measures of interconnectedness and common risk exposures) – for a comprehensive summary, see Financial Stability Board (2011).

11 Selody and Wilkins (2010, 30) define a systemic event as one that "creates a widespread shortage of liquidity that disrupts a wide range of institutions and markets, distorting asset prices more generally." This definition leaves room for interpretation and discretion. In the case of the most recent financial crisis, no special perspicacity was required to recognize the complete freezing up of the Canadian ABCP market as a systemic event.

More can be done in the literature on macroprudential regulation on the fundamental sources of instability in financial markets or about the source of market failures and/or externalities that make regulation necessary. The 2007–08 financial crisis might have fostered the idea that financial markets (and capitalism in general) are inherently unstable, but, as Calomiris and Gorton (1991) argue, there are historical examples of stable financial markets, and institutional design does seem to matter. A clearer identification of potential market failures and their importance would help to focus the analysis.[12] Examples include the following:

- market liquidity inherently involves a network externality (Buiter 2012);
- because of asymmetric information, financial markets are inherently prone to multiple equilibria and runs or panics (Gorton 2010);
- related to these information problems, external costs are associated with firms that attempt to divest themselves suddenly (fire sales) of assets they believe will lose their value (Hanson, Kashyap, and Stein 2011);
- again because of asymmetric information, firms are limited in their borrowing by their perceived ability to repay their loans, and small shocks that affect their net worth can have strong feedback effects (Bernanke, Gertler, and Gilchrist 1996);
- a decline in expectations concerning future revenues can lead to a crash in asset prices because of changes in equilibrium leverage and the bankruptcy of the most optimistic individuals (Geanakoplos 2009);
- the moral hazard created by central banks' credit policy can itself lead to excessive risk taking by financial firms that believe the central bank will bail them out;
- that the failure of a significantly sized bank leads to the inability of

12 Jeanne and Korinek (2016) explicitly model the interaction between macroprudential regulation and monetary policy in a model in which borrowing is constrained by the availability of collateral.

its small and medium sized business borrowers to borrow further; and
- that the failure of more than one large bank can often lead to a credit crunch.

Bernanke (2011) spells out the potential scope for macroprudential policy: "[B]ecause of the highly interconnected nature of our financial system, macro-prudential oversight must be concerned with all major segments of the financial sector, including financial institutions, markets, and infrastructures; it must also place particular emphasis on understanding the complex linkages and interdependencies among institutions and markets, as these linkages determine how instability may be propagated throughout the system." This statement recognizes that macroprudential policy must be complex, but it understates the importance of this complexity by implying that central banks are up to the task of understanding these complexities.

Currently, the Bank of Canada's main focus is on monetary policy, which entails bringing the inflation rate back to 2 percent within a period of eight quarters in most circumstances. Subject to many caveats about the choice of the inflation measure (see the next section) and the "flexible" part of flexible inflation targeting, which opens the door for the stabilization of fluctuations in real variables, this is a fairly clear and limited goal. In its role as inflation targeter, the Bank already has many requirements for the information it needs and the intellectual and computing power to process this information.[13] The information required, however, to tailor monetary policy so that it targets financial stability as well as inflation is an order of magnitude more complex. Assessing the systemic importance of individual institutions involves detailed knowledge of how equilibria are determined in financial markets

13 For this reason, monetarists such as Friedman (1968) and Simons (1936) have suggested limiting monetary policy to the mechanical execution of simple rules.

and judgments about the quantitative importance of the externalities imposed by systemically important institutions on those market equilibria. This is precisely the "pretense of knowledge" problem Hayek (1989) highlighted in his Nobel Prize address.

Assessing systemic risk involves the statistical analysis of many different disaggregated time series. If there are important structural differences from one financial crisis to the next, and if the next serious financial crisis originates in a market that so far has escaped the attention of risk analysts, it seems likely that the time series used to estimate risk will be too short for one to have any confidence in the results. Indeed, as Kohn (2014) notes, "[i]n addition, systemic risks often involve the tails of distributions – vulnerabilities to unexpected developments." Financial time series are also known to deviate significantly from normal distributions, with "fat tails," a point argued forcefully by Taleb (2013), who claims that risk assessment is practically impossible even at the level of individual stocks and companies.[14]

These arguments suggest strongly that central banks, or any other analysts, might be unable to evaluate the importance of systemic risks with precision, and that simple heuristic policies should be used to analyze and deal with potential financial crises (see Haldane and Madouros 2012). Unfortunately, recent proposals for combatting financial crises seem to be headed in precisely the wrong direction. For example, regulations for capital requirements for financial institutions are becoming increasingly complex, creating unintended consequences for banks' incentives to skew their holdings toward assets that require little offsetting capital holdings. Haldane and Madouros (2012) note that the Basel I Accord on the supervision of banking regulations defined five different risk weights and was 30 pages long; the Basel II Accord

14 Dowd (2014) also argues that risk assessment by the US Federal Reserve and other central banks is fundamentally inadequate because of tail risk.

was longer by an order of magnitude – 347 pages; while the Basel III Accord, at 616 pages, was almost double the length of the previous agreement.

Implications for the Bank of Canada

Whether macroprudential regulation is based on simple heuristics or on complicated models of systemic risk, more regulation would entail more non-market control over the allocation of resources (as Salter 2014 stresses). As with credit policy, this, in turn, has distributional consequences. For this reason, macroprudential policy should be the responsibility of a separate body, rather than entrusted exclusively to the Bank of Canada. Because of its expertise, the Bank should be a member of such a body, but the Department of Finance should hold the chair in recognition of the allocative and fiscal implications of its policies, and hence the need for more direct accountability to the electorate. The body should focus on coming up with simple and robust heuristics to assess financial imbalances, while the Bank should use the overnight rate to achieve its monetary policy goals, not to affect financial stability. The independent body responsible for financial stability should use a different set of instruments than those the Bank uses to conduct monetary policy. The Bank should remain responsible for providing overall liquidity to the financial sector, with allocations to specific institutions subject to market forces, and it should refine and make more precise the list of principles outlined above.

Bank of Canada Governor Stephen Poloz (2015a) has noted that different advanced economies have different governance models for macroprudential policy. In many cases, the mandate is centralized – sometimes within the central bank, as at the Bank of England, or outside the central bank, as in the United States. Some macroprudential bodies have the power to write regulations; others are limited to monitoring and making recommendations.

Poloz states that "it's crucial that central banks be involved," with which we would concur, but he is otherwise agnostic as to which model is suitable. The implications of credit policy for the Bank's accountability and independence, however, argue strongly in favour of not centralizing the mandate within the Bank.[15]

The Bottom Line

To summarize our blueprint for financial stability policy based on Buiter's (2012) four points, the Bank of Canada should continue to refine and extend its guidelines for extending liquidity to financial markets. In particular, it should consider under what limited circumstances it would extend credit bilaterally to individual financial institutions while still favouring a market-based allocation mechanism. We review the topic of emergency liquidity in more detail in the next chapter.

The Bank should also consider if and under what circumstances it would intervene in frozen markets for particular asset classes by acting as market maker of last resort. The Bank should also acknowledge the inherent limitations of assessments of misalignment in financial markets and systemic risks, and macroprudential policy should concentrate on simple heuristic strategies based on the principle of "skin in the game." To the extent that macroprudential policy involves non-market control over the allocation of resources, it would be better for the Bank to participate as one of several experts in an independent body tasked to promote financial stability. Otherwise, it would leave itself open to criticism for a lack of accountability and thereby risk jeopardizing

15 Kohn (2014) compares the UK model, in which the mandate is centralized with the Bank of England, and the US model, where a separate body has been set up, and concludes in favour of the latter.

its operational independence. The independent body should be directly responsible to the Department of Finance.[16]

The Measurement and Relevance of Core Inflation

The current inflation-targeting regime obliges the Bank of Canada to bring headline (CPI) inflation back to the 2 percent target within a period of eight quarters. The CPI contains many components that are quite volatile and subject to idiosyncratic shocks. For this reason, many central banks, including Canada's, look at some measure of "core" inflation that strips out the volatile components when formulating their monetary policy. Côté (2014) notes that an "effective core measure must have four key properties. It must be less volatile than total inflation; track long-run movements in the total CPI very closely (in other words, be 'unbiased'); reliably predict future trend movements in the total CPI; and be easy to understand and explain to the public."

Prior to the 2016 inflation-control agreement renewal, the Bank used the CPIX index as its preferred core price index.[17] The CPIX excludes eight of the most volatile components of the CPI (fruit, vegetables, gasoline, fuel oil, natural gas, intercity transportation, tobacco and mortgage interest costs), adjusting the remainder for the effect of changes in indirect taxes. The Bank found the measure to be ineffective, however, when measured against the four properties described above. As a result, it began a process to find a better core CPI tool to act as an operational guide.

16 There is broad consensus in previous work published by the C.D. Howe Institute that the Bank should not be given sole and full responsibility for financial stability; see, for example, Crow (2012); Jenkins and Longworth (2015); Jenkins and Thiessen (2012); and Ragan (2012).

17 For a survey of different possible measures of core inflation, see Khan, Morel, and Sabourin (2015).

The Bank's research and evaluation led it to adopt measures that better track the output gap – an important result when the primary transmission mechanism for monetary policy to affect inflation is through demand – and are less sensitive to temporary sector-specific shocks. Three such measures now jointly serve as operational guides. The first measure, CPI-common, follows common price changes across components of the CPI basket. The second measure, CPI-trim, removes both upside and downside outliers. The third measure, CPI-median, focuses on the median inflation rate across the different CPI components. The Bank believes these measures better capture persistent price changes and are correlated with macroeconomic variables that are affected by monetary policy. Although we agree with looking at how to improve the measurement of core inflation, lacking from the Bank's analysis was a more comprehensive and theoretical view as to how core CPI can be used to predict future trend movements in the total CPI reliably. We turn to this theoretical analysis next.

Core Inflation as a Predictor of Inflation

First and foremost, if the Bank of Canada were to use core inflation as an indicator when setting the overnight rate to target headline inflation, then core – or any other indicator, for that matter – should be a poor predictor of inflation at times close to the Bank's self-imposed eight-quarter period for bringing inflation back to target. In fact, the best predictor of inflation eight quarters ahead should be the target rate itself. A fairly long line of research, including research at the Bank itself, demonstrates this result (see, for example, Clinton 2006a; Otto and Voss 2014; Rowe and Yetman 2002).

The argument is simple. The Bank uses all information currently available (including core inflation), plus its model of the Canadian economy, to set its policy rate. The interest rate is set so that, in the absence of unexpected shocks, inflation will return to its target within the eight-quarter limit. If information available to the Bank helps to predict the deviation of inflation from its target eight quarters later, the Bank will not have set its policy rate optimally.[18]

Core inflation, in contrast, could help as a predictor of future inflation only at horizons much shorter than the Bank's eight-quarter limit. Even at such shorter horizons, however, if the Bank's policy closed the gap between current headline inflation and the target rate in a monotonic fashion, the current gap should be close to the best predictor of inflation.[19]

Core Inflation as a Target

Instead, it is possible to use some measure of core inflation as the actual target, rather than just as an indicator of the direction in which inflation is heading in the short run. It would be beneficial, therefore, to replace headline inflation with some measure of inflation similar to core as the actual target. Targeting an appropriate price index other than the overall CPI could lead to improvements in economic welfare.[20] Let us review why.

If the CPI contained some stickier components, economic welfare could be enhanced by stabilizing those components and allowing the more flexible components – which are inherently closer to their welfare-maximizing flexible-price values – to adjust by themselves. This would mean targeting an index with components weighted by their degree of stickiness. Note that, as long as these

18 The Bank's policy rate is optimal within the context of its main forecasting and policy analysis tool, ToTEM II. If information outside the model helps to predict inflation, this would suggest dimensions along which ToTEM II should be modified to improve its performance.

19 Poschmann and Jacobs (2014) show that an index generated as the principal component of 167 subindices of the CPI forecasts the overall CPI well at horizons out to between six and eighteen months.

20 For the relevant theoretical arguments, see, for example, Aoki (2001); Dhawan and Jeske (2007); and Erceg, Henderson, and Levin (2000).

components move in trend with the CPI, the CPI itself would increase on average at the same rate as the targeted index: the distributional consequences and loss of credibility associated with a change in the targeted rate of inflation would not apply.

These are more than just theoretical results. It is relatively straightforward to calculate a price index adjusted for the degree of stickiness of its components. The Federal Reserve Bank of Atlanta already does so, and publishes its data on the same day as the release of the official CPI statistics. Bryan and Meyer (2010) explain the methodology used: the degree of stickiness depends on the average frequency of price adjustment in a given sector. The authors also show that stickier prices are more forward looking than flexible prices, helping to forecast inflation at very short horizons. Finally, they find the flexible-price CPI to be more sensitive to measures of economic slack than is headline inflation. Although the Bank of Canada's new CPI measures get closer to this ideal, they do not go all the way.

One strong implication of the theoretical literature is that it would be optimal for a central bank to stabilize all prices to the extent that they are sticky. Monetary policy can provide a stable and predictable price level, and it can also help move prices toward what they would be if they could adjust freely. It would be better to stabilize prices that are slow to adjust, and to allow prices that adjust quickly by themselves to do so. This would extend to wages if they are sticky (Erceg, Henderson, and Levin 2000).[21] An appropriate target to maximize economic welfare should include a combination of prices and wages, weighted by relative stickiness, and adjusting

21 De Resende, Dib, and Kichian (2010) compare the benefits of targeting headline inflation versus individual components of the overall price index, and find that targeting headline inflation does as well or better. However, they do not look at an index with weights on components that depend on the degree of stickiness or one that incorporates wages, even though their model includes nominal wage rigidity.

targeted wage growth for productivity gains.[22] The target growth rate for the appropriate goods price index could still be 2 percent.[23] Using such an index, however, would pose a communications challenge for the Bank of Canada. The Bank currently reports the value of core inflation, but it could follow the lead of the Federal Reserve Bank of Atlanta by providing on its website the necessary data and methodology for computing a modified index.[24]

Core Inflation and Level Targeting

We suggested earlier that level targeting must be symmetric to be credible and, therefore, effective. A central bank thus must correct the effects on the price level of both negative and positive shocks to inflation. A common objection to price-level targeting is that the central bank would face substantial political resistance if it were obliged to engineer a substantial reduction in inflation in response to a strong positive energy price shock. The literature concerning the choice of the appropriate price index to target puts a very low weight on energy prices or excludes them altogether, because – especially for a small, open economy such as Canada's – energy prices are determined on world markets, and are not subject to influence by a central bank. Barring persistent shocks to the relative prices of energy and other commodities, the average rate of inflation of the targeted index would track overall CPI inflation. By targeting the appropriate index, the central bank would not have to restrict aggregate demand and, in extreme cases, engineer

22 Because of trend productivity gains, real wages in the Canadian economy are rising, implying that average nominal wages and the price level diverge over time.

23 The appropriate weights to put on wage stability versus price stability would have to be determined within the context of a model such as the Bank of Canada's ToTEM II.

24 The methodology for the new measures can be found on Statistics Canada's website, at http://www23.statcan.gc.ca/imdb-bmdi/document/2301_D64_T9_V1-eng.htm.

a recession to bring the price index back on track. On the other hand, positive inflation shocks due to aggregate demand shocks would lead the central bank to offset them using monetary policy, and level targeting could lead to greater stability of both inflation and output.[25]

The Bottom Line

The search for a measure of core inflation with high predictive power is somewhat misplaced. If the Bank of Canada has done its job well, and used core inflation as one of its indicators in setting the overnight rate, then after-the-fact core inflation should have very little predictive power for headline inflation in the Bank's self-imposed period for bringing headline inflation back to target. There are strong arguments for actually targeting a core-like measure of inflation in which components of the index are weighted by their degree of stickiness. Targeting such an index could lead to increased economic welfare by making monetary policy more effective, even if it is overall headline inflation that is costly to households. Although the 2016 agreement got us closer to such an index, we believe it would be worthwhile for the Bank to consider the proposals we make in this section.

Conclusion

There was much to like about the 2016 renewal of the inflation-control agreement between the federal government and the Bank of Canada. The inflation target was kept at 2 percent and the temptation to raise it was resisted; the important but necessary separation of monetary policy and financial stability was well established; and a deeper investigation of the quality of core CPI

25 Ambler (2009, 2014) details how price-level targeting could lead to increased inflation and output stability in response to demand shocks.

measures was undertaken. Further steps are possible that, in our opinion, would be beneficial:

- consider modifications to the monetary policy framework up to and including level targeting;
- refine and expand the Bank's guidelines for liquidity provision in times of crisis;
- seek simple heuristic approaches to promote financial stability;
- refrain from taking on direct responsibilities vis-à-vis financial stability that have significant allocative or distributional consequences;
- reserve the overnight rate to target monetary policy objectives; and
- consider targeting a price index that strips out volatile and non-sticky components, rather than using it just to predict movements of overall headline inflation.

PART IV

Toward the 2021 Renewal of the Inflation-Control Agreement

Chapter 11

Liquidity Provision

In the 2016 inflation-control renewal agreement, the Bank of Canada identified issues for further research as it looks ahead to the 2021 renewal:

- continued research on how the Bank communicates with the public, a focus that comes as a result of the many communications changes that were required in response to the use of unconventional monetary policy;
- continued analysis of the role and effectiveness of macroprudential regulation and how it affects monetary policy, which, in turn, would help the analysis of the optimal mix of monetary policy, macroprudential regulation and fiscal policy;
- assessment of the effectiveness of unconventional monetary policies and whether they should be added to the Bank's standard tool kit; and
- assessment of the ability of monetary policy to stimulate the economy given its track record since the Great Recession.

We have discussed our responses to these first two areas in previous chapters. Over the course of the next two chapters we look to get the ball rolling on the final two bullets.

Emergency Liquidity Introduction

Since the end of the 2007–08 financial crisis the search has been on for policies that could prevent any future financial stress from becoming a full-blown crisis. Providing a liquidity and funding backstop is a key responsibility of the authorities as part of their crisis preparedness. One lesson from the recent systemic stress on the financial system is that there should be no delay getting liquidity to market. Although a lack of liquidity might not be the cause of a crisis, its loss in the aftermath of major negative shocks has severe and long-lasting consequences.

From the onset of the recent financial crisis, central banks across the developed world used different forms of extraordinary liquidity facilities, in many cases temporary, in attempting to provide much-needed liquidity, stimulate credit markets and get their economies back on track. The scramble to provide liquidity demonstrates the need to establish market-wide, predefined emergency liquidity mechanisms to respond to any future financial crisis. Regrettably, although the Bank of Canada reserves the right to bring back the measures it introduced during the last crisis, this discretionary approach to policy makes it difficult from a transparency perspective to assess its crisis preparedness, and impairs our ability to suggest improvements to its ongoing design.

Since the crisis, Canadian bank regulations have changed, but the new policies are untested in crisis conditions. In addition, the federal government has changed its willingness to assume risk in the housing sector[1] and its approach to emergency liquidity backstops for major provincial institutions. Furthermore, a major concern regarding the next crisis is the speed with which a negative shock might be propagated to all financial institutions and to the economy as a whole. Without a clear understanding of when market-wide emergency liquidity measures would be available, financial institutions are left in the dark. Lessons from the previous crisis, and

1 For example, by lowering the amount of new mortgages it insures from 90 percent during the financial crisis to approximately 50 percent today (Dmitrieva 2015).

developments since, call for changes to Canadian monetary policy authorities' approach to crisis liquidity arrangements.[2]

Emergency Liquidity Facilities Worldwide

In determining if the Bank of Canada should have permanent, predefined, market-wide emergency liquidity facilities, it is important to understand not only what the Bank did during the Great Recession,[3] but also the types of emergency liquidity facilities that were introduced during the crisis in other countries.[4] As it turns out, the specific facilities introduced in the United States and the United Kingdom, two countries in which the crisis was significantly more severe than in Canada, were similar in design to those in Canada and addressed similar issues. Specifically, each of the three countries introduced emergency liquidity mechanisms in attempting to fix the drying up of longer-term lending, the abundance of highly illiquid assets and the freezing up of markets responsible for continued lending to households and businesses (see Table 11.1).

One additional deficiency arose in the United States – namely, that of having institutions that needed emergency liquidity, yet

2 Much of the work discussed in this chapter can be found in Kronick (2016b).

3 As our focus is on central banks, we do not discuss other forms of effective lending to financial institutions that took place during the crisis. One significant example is the Insured Mortgage Purchase Program, whereby the federal government, through the CMHC, purchased National Housing Act Mortgage-Backed Securities, a form of bond that has a pool of guaranteed mortgage loans as its underlying asset. Financial institutions, in return, received cash payments in the hope that they would produce new loans for consumers and businesses (Nadeau 2009).

4 See Lavoie, Sebastian, and Traclet (2011) for a complete summary of emergency liquidity facilities used in Canada and around the world. Plenderleith (2012) and Winters (2012) provide a comprehensive review for the United Kingdom. For details of these liquidity facilities for the United States, see Board of Governors of the Federal Reserve System (2010).

Table 11.1: Emergency Facilities Underlying Liquidity-Related Issues, Canada, United States, and United Kingdom

Major Issue for Facility	Canada	United States	United Kingdom
Injection of more longer-term liquidity	Term Purchase and Resale Agreement	Term Auction Facility	Term Auctions Extended Collateral Term Repo Indexed Long-Term Repo
Substituting less liquid for more liquid assets	Substitution of Non-mortgage Loan Portfolio for more marketable securities Term Loan Facility	Term Securities Lending Facility	Special Liquidity Scheme
Enhance functioning of markets responsible for lending	Term Purchase and Resale Agreement for private sector instruments	Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility Commercial Paper Funding Facility Money Market Investor Funding Facility Term Asset-Backed Securities Loan Facility	Asset Purchase Facility (Corporate Bonds) Funding Lending Scheme
Including institutions without access to traditional liquidity facilities	Not Applicable	Term Securities Lending Facility Primary Dealer Credit Facility	Not Applicable

Source: Kronick 2016c, Table 1.

were ineligible to access other facilities for one reason or another. To address this gap, the United States was forced to introduce specific facilities: the Term Securities Lending Facility and the Primary Dealer Credit Facility. Canada, on the other hand, faced no such problem. Also worth noting is the fact that, although Canada and the United States have wound down many of these emergency liquidity facilities and their future use is at the discretion of their central banks, the United Kingdom chose to keep many of its facilities in place – in effect, deciding that the potential future benefits outweigh the potential moral-hazard costs, as we discuss next.

Next Steps

Because the extraordinary facilities introduced during the financial crisis were temporary, the Bank of Canada may struggle to address a future market-wide crisis quickly. The goal in times of stress should be to restore confidence in as timely and effective a fashion as possible. As mentioned, the Bank has said it reserves the right to relaunch the emergency facilities if necessary, but since these facilities are discretionary, a more nuanced, ongoing discussion of their design is needed, both internally at the Bank and externally. In the post-crisis era, as analysts and policymakers sort through the myriad new regulations and deal with a constantly evolving financial sector, these types of transparent discussions are vital for the well-functioning of the market.[5] Although the Bank might be ready operationally to bring back these extraordinary facilities at a moment's notice, it is not clear to financial institutions exactly when

5 During the crisis, financial institutions became worried about counterparty credit risk and illiquidity in the repo market, which is a key funding market in the Canadian economy. To boost confidence in stressful times, in 2012 the Canadian Derivatives Clearing Corporation introduced a central counterparty service that acts as a buyer or seller on each transaction (including repos) to mitigate any future counterparty credit risk concerns; see Chatterjee, Embree, and Youngman (2012).

they would be able to access them in an environment of stress if they are not part of the Bank's tool kit on a day-to-day basis.

What is now required is a predefined mechanism to address the need for longer-term lending when liquidity is at a premium, to ensure firms are able to exchange less-liquid assets for more-liquid ones, to permit institutions to pledge an expanded amount of collateral, to create an incentive for important players in the credit market to continue to lend to the real economy and to encompass all relevant financial institutions. Having more predefinition now would make clearer contingency planning possible, and could make it easier to specify conditions that would reduce gaming and moral hazard and ensure more appropriate pricing. From a qualitative standpoint, the features of the two forms of Term PRA, as well as the Term Loan Facility, are sufficient to address all these needs.

Costs and Solutions

The establishment of permanent, emergency, market-wide liquidity facilities would come with costs, of course, of which the primary one is moral hazard. If banks assume that, no matter the circumstance, they will always have liquidity support, they will have less incentive to be prudent in their liquidity behaviour. This legitimate concern need not be a reason, however, for leaving future arrangements as undefined as they are now.

The details of arrangements matter a lot in attempting to mitigate moral hazard. One option is to make liquidity support unappealing – for example, by having financial institutions pay a stiff fee. The exact nature of this cost could be flexible so that financial institutions would not be able to prejudge how they would be affected by accessing this form of liquidity. There would be some risk in charging a high fee, however, as it would stigmatize the usage of liquidity support, which might cause financial institutions not to seek it out when they should (Rule 2013). On the other hand, it might be easier to set an appropriate fee now, rather than in the midst of a brewing crisis.

Another option comes directly out of two of the Bank of Canada's five principles that guide extraordinary liquidity intervention – namely, that intervention should be commensurate with the severity of the problem and that the Bank should mitigate the moral hazard of its actions through limited, selective intervention (Longworth 2010).[6] The solution, then, might be to set up the facility such that the market could access it only when certain negative financial metrics were met. The stigma associated with accessing the facility would still exist, but moral hazard should be somewhat reduced. The key is to make these metrics clear.

In addition, now that banks' liquidity is explicitly regulated and banks have to provide acceptable (stressed) liquidity recovery and contingency plans, a range of other tools is available to ensure that they do not skimp on liquidity just because the Bank of Canada becomes clearer about the emergency facilities that would be available in a crisis. One requirement, now in place, is that all domestic systemically important banks report their liquidity coverage ratios as often as they publish financial statements. Furthermore, the Office of the Superintendent of Financial Institutions will assess the liquidity situations of financial institutions using their liquidity coverage ratios, net stable funding ratios and net cumulative cash flows. These disclosure and supervisory tools make destructive liquidity risk taking difficult, and with the comprehensive rules set out in the Basel III global regulatory framework, the type of behaviour that led to the 2007–08 financial crisis seems unlikely to

6 The other three such principles are that the measures should be targeted, well designed and efficient or non-distortionary.

repeat itself. Therefore, the kinds of negative shocks that could set off a crisis likely would not be due to poor liquidity-based decisions.[7]

Another common argument for leaving all market-wide emergency liquidity discretionary is that there is no reason a central bank should provide this type of funding in normal times when the market can provide it. That might be true – and again, rules can be set up to make it unappealing, or even impossible, to access this funding in normal times – but we need to acknowledge that the new post-crisis rules for financial institutions mean the primary and secondary markets for liquidity have changed.

When banks' liquidity coverage ratios are assessed, eligible assets include only high-quality liquid assets such as cash, government bonds, and investment-grade corporate debt. The idea behind such assets is that they can be turned easily into cash during times of stress. Again, this rule is meant to mitigate the types of behaviour that can lead to systemic breakdowns. The downside of such a measure, however, is that the amount of liquidity in the global system, including in secondary markets, is much lower than it used to be. For example, in the United States, daily trading volumes of agency mortgage-backed securities fell from US$321 billion in 2010 to US$178 billion in 2014 (PwC 2015). This trend has direct implications for financial institutions, as it reduces their ability to access liquidity. Furthermore, this secondary market will only become more illiquid with interest rates as low as they are and likely will remain. The implication, then, is that the ability of financial institutions to transact in times of future financial stress will be lessened, so having an effective permanent, predefined mechanism in place could be very beneficial.

7 Furthermore, with the bail-in system, eligible debt on banks' balance sheets will be written down and/or turned into equity. Although the focus of bail-in is capital, not liquidity, it should reduce moral-hazard concerns to some extent.

Another reason to keep the emergency mechanisms in the day-to-day tool kit is the increased speed with which idiosyncratic negative financial shocks can become systemic. An example of this contagion from an idiosyncratic negative shock is a cyber attack that can cause a significant hit to a bank's balance sheet overnight, leading to a run on even a well-run bank and a massive hit to liquidity. Even if the cyber attack hits only one institution, the viral nature of news today could cause a crisis of confidence at other financial firms. Another scenario is an attack on a firm that provides inputs to banking (a payments interface, for example), which would immediately affect more than one bank. These scenarios underscore the need to have market-wide liquidity available instantaneously.

Without the ability to perform a quantitative cost-benefit analysis on predefined mechanisms, however, we are required to make a judgment call. We argue that the benefits listed above outweigh the costs, especially given the possible tools to deal with moral hazard. In addition, a predefined, market-wide emergency liquidity mechanism would not remove all of the Bank of Canada's flexibility: it could still introduce new facilities during a future crisis if those in place cannot address all concerns, and in doing so, the Bank could continue to be guided by its five principles of liquidity intervention.

How to Auction or Price a Predefined Mechanism

How should a market-wide permanent emergency liquidity mechanism be priced? First, let us review how extraordinary facilities have been priced in Canada in the past.[8] By analyzing the

8 Since terms and conditions for the auctioning of the Contingent Term Repo Facility will only be disclosed when activated, we do not consider its pricing here. We also do not discuss the auction mechanism for term repos, as they are not intended for liquidity purposes.

costs and benefits, we can determine a set of characteristics that would make up an ideal auction design.

Canadian Auctions

For Canada's three different Term PRA Facilities, a multiple-yield auction was used. This auction was a single-round event, meaning that all funding was distributed simultaneously, with a maximum of either two or three bids allowed. Minimum bids, in terms of value, were put in place for each, and in both the Term PRA for private sector money market instruments and its successor, the Term PRA for private instruments, minimum rates above the target overnight rate were established and announced before the auction. In all three cases, winning bids were awarded by descending order of yield – that is, by discriminatory pricing. Specifically, the highest bid was accepted and the yield-bid paid, and this continued until the total funds intended for allocation were sold. In terms of collateral, bidders specified after the auction the type of collateral they were pledging.

A few issues arise with this form of auction. First, there is the distortion of optimal pricing and distribution of ideal liquidity, which occurs when the amount of bids is restricted, thereby limiting the ability of bidders to show how much they would bid at each price – that is, create a complete demand function. This distortion on the demand side prevents the true competitive equilibrium price and quantity from being established for the different forms of collateral within the auction. Furthermore, by setting a minimum rate above the target overnight rate, the Bank of Canada runs the risk of mispricing and, in any event, restricts the creation of its own complete supply curve, exacerbating the inefficiencies seen on the demand side. Therefore, to create a competitive equilibrium for a given collateral, ideally there should be unlimited bidding and no minimum rates that sit above the overnight target rate.

It is important to explain why minimums above the benchmark overnight rate exist in the first place. First, they work as a penalty and help to mitigate moral hazard. Second, if atypical repo borrowers are allowed access to these facilities, they should be forced to pay more than normal primary dealers do. On the first point, however, if a stiff fee is set for accessing the facility in the first place, any additional penalty is redundant. On the second point, if atypical borrowers are allowed in, a scenario is created in which there will be excess demand at the minimum rate in any case, which will push up the price for this facility and generate a higher cutoff rate. If discriminatory pricing is allowed, therefore, it likely will end up with a required paid price above the minimum benchmark rate.[9]

Canada's Term Loan Facility auction was also undertaken in a single round, allowed only two bids, and had a minimum bid value and a rate established before the auction. In that sense, it suffered from many of the same inefficiency issues as the Term PRA Facilities.[10] Furthermore, the way bids were accepted or rejected was determined by the minimum accepted yield determined by the auctioneer. Funds were allocated at bids at or above this minimum, with all winning bids per participant combined into a single transaction paying the same price – that is, uniform pricing. In the case of general term loans, as opposed to term repos, it makes sense to have uniform pricing, since part of the reason to have

9 It is true that by setting the rate higher, market liquidity may be filled by normal repo market participants, who will then ideally provide the liquidity to atypical borrowers, thus fulfilling the Bank's principle of not crowding out market transactions. The central bank must judge whether this market liquidity provision will occur during a crisis period.

10 The big exception here is the minimum rate, which in the case of auctioned loans, is not considered an inefficiency. All Bank of Canada loans, including auctioned loans, have penalty rates, because they are lender-of-last-resort loans and follow the Bank of Canada's principles. Moreover, by law, all Bank of Canada loans must be at an interest rate at least as high as the Bank Rate and the Bank Rate needs to be above the target overnight rate to be an appropriate penalty rate.

loan auctions is to avoid the stigma associated with individual institutions accessing the Standard Liquidity Facility in large amounts on a regular basis. Since financial institutions that can access the Standard Liquidity Facility pay the Bank Rate, they might balk at participating in the auction if they ran the risk of having to pay above the overnight minimum rate.

These descriptions of the Bank of Canada's auction designs make clear that, although they had many appropriate features (see Table 11.2), improvements would ensure a more optimal outcome for the distribution of liquidity to the market.

The Ideal Design

In the United Kingdom, the Indexed Long-Term Repo was auctioned using the "Product-Mix" design (Klemperer 2010). In this design, the seller – in this case, the Bank of England – auctions different forms of collateral with a differing range of associated risks, and the per-unit price of these forms of collateral is the interest rate. Bidders, consisting of various financial institutions, may make an unlimited number of bids. Each bid must include an offer of a per-unit price for each variety of collateral. So, for example, one bid might be for $500 million at 5.5 percent for the strongest collateral, at 5.8 percent for a weaker collateral and at 6.0 percent for the weakest collateral. Each offer can be thought of as mutually exclusive. These unlimited bids for different forms of collateral allow bidders to create a complete demand function. They also create a situation in which, in theory, they choose how much to buy after seeing the prices, leading to less error on the part of bidders or their paying too much for a particular variety of collateral – the so-called winner's curse. It should also allow bidders to better organize the liquidity and risk of their portfolios.

Once all bids have been sent in, the auctioneer then analyzes them to establish a minimum cutoff price for each variety of

Table 11.2: Characteristics of Facilities Using Auctions, Canada

	Unlimited Bids	No Minimum Bid/Rate[a]	Single Round	Simul-taneous Bidding[b]	Multiple Collateral[c]
Term Purchase and Resale Agreement	no	no	yes	yes	yes
Term Purchase and Resale Agreement – Private Sector	no	no	yes	yes	yes
Term Purchase and Resale Agreement – Money Market	no	no	yes	yes	yes
Term Loan Facility	no	yes	yes	yes	no

Notes:
a Answering "no" to No Minimum Rate means a minimum above the benchmark rate was set by the central bank. See Footnote 10 for further detail on the minimum rate for the Term Loan Facility.
b Different forms of collateral can be used in bids.
c Must allow for different final sale price for each form of collateral.

Source: Adapted from Kronick 2016c, Table 3.

collateral. The auctioneer is able to analyze demand before choosing prices, which, similar to bidders' submitting bids at different price levels, reduces inefficiencies. In making the determination for cutoff prices, the auctioneer needs to consider the central bank's primary concern. In many cases, it will be to inject a certain level of liquidity into the system. If total liquidity is the primary concern, then the cutoff yields, taken in their entirety, will have to create this amount of funding for the market.

At this point, the auctioneer must accept all bids for a given variety of collateral that are above the minimum cutoff price.

However, the auctioneer can accept only one offer from each bid. So, in the example above, only one collateral and price combination is used for the $500 million bid. If more than one offer happens to be above the respective minimum cutoff price, the central bank will accept the bid that maximizes the bidder's surplus, which can be measured as the distance between the minimum price for each variety and the bid offer. The last step is payment: for each accepted offer that exceeds the minimum price, the bidder pays this minimum for the particular form of collateral. In other words, there is uniform pricing.[11]

One area of debate surrounds uniform versus discriminatory pricing. One argument for discriminatory pricing is that, if the goal of the auction is to get an honest valuation from bidders, discriminatory-price models are more likely to produce this result, since, in the uniform-price model, bidders tend to use steeper bid curves than their true valuations support. Furthermore, in both theory and practice, collusion tends to be reduced in discriminatory pricing (see Monostori 2014).

The argument for uniform pricing, however, is that, since discriminatory-pricing bidders know they will pay the full bid amount, they will bid less than their true valuation so as to be better off when they win. These lower bids imply that bidders create much flatter bid curves than their true valuations, so that the maximization of central banking revenue will not be realized. By contrast, in a uniform-price auction with a reasonable number of bidders, bids will be at full valuation because financial institutions are aware that the values they bid almost certainly will affect only whether they win or lose, not the price they pay if they win. The argument then is

11 Note that the current version of the Bank of England's "Product-Mix" auction design uses a more endogenous total quantity, whereby the amount of money the Bank puts out in the market varies based on the bidding of financial institutions. Also, it uses increased dimensions to determine the different qualities of collateral.

that, with discriminatory pricing, the effect of steeper bid curves is dwarfed by the effect of flatter curves, while the loss from uniform pricing is offset by aggressive bidding. Furthermore, because of difficulties in determining how to bid, discriminatory pricing discourages bids from financial institutions in times of crisis.

Overall, in the absence of a quantitative analysis, the conservative approach would be for the Bank of Canada to stick with what it did during the 2007–08 financial crisis, and use discriminatory pricing in the repo cases and uniform pricing in the loans cases. The latter is assuredly the appropriate format, given our earlier discussion on the design of the Term Loan Facility and Standing Liquidity Facility. Therefore, using the "Product-Mix" design as a template, with the uniform versus discriminatory pricing adjustment, a set of ideal auction characteristics would emerge: specifically, single-round auctions that generated complete demand-and-supply functions through unlimited bidding and by not announcing any form of reference or minimum price above the benchmark rate, with the exception of auctioned loan facilities which are required by law to set the Bank rate as the minimum rate. Furthermore, all collateral would be sold simultaneously with individualized pricing, and bidding would be allowed for different collateral within the same bid.

Conclusion

The key takeaways from this chapter are, first, the merits of having predefined, permanent, market-wide emergency liquidity mechanisms as part of the Bank of Canada's day-to-day tool kit – a direct response to one of the Bank's research questions. The permanence of such a facility would improve the transparency needed to ensure a well-functioning financial sector, and would allow the Bank to ameliorate its design as financial conditions evolve. Solutions are also available to deal with moral-hazard concerns. Second, although the extraordinary facilities the Bank introduced during the financial crisis were sufficient to meet the needs of Canadian financial institutions from a design standpoint, the format used to auction these market-wide facilities to bidding financial institutions likely did not create the competitive prices and quantities needed for the Bank to generate the highest possible return and to put liquidity in the hands of the appropriate financial institutions. Accordingly, we suggest using the "Product-Mix" auction design, which would generate complete demand-and-supply schedules in an unlimited bid, single-round process in which bids are made on different forms of collateral simultaneously, and no minimum reference price above the benchmark overnight rate is established in advance, except in the case of loan facilities. From a pricing standpoint, we recommend sticking with the approach the Bank used during the financial crisis – namely, discriminatory pricing for the different term repos and uniform pricing for the Term Loan Facility.

Chapter 12

Monetary Policy and Its Transmission to the Canadian Economy

In this chapter, we focus on the Bank of Canada's ability to stimulate the domestic economy. Given the weak recovery and tepid inflation since the Great Recession, this question has rightly been highlighted by Canada's central bank. In our survey of the economic landscape, we think two areas in particular will continue to affect the transmission of monetary policy onto the real economy: housing and demographics.

Housing Markets and Monetary Policy

We first touch on the link between the housing market – more specifically, debt – and household consumption and its likely effect on monetary policy.[1] Monetary policy, to reiterate, affects inflation through its influence on aggregate demand. As household consumption is a significant portion of aggregate demand and housing is often both the largest asset and the largest debt load that consumers ever take on, it makes sense to evaluate its interaction with monetary policy.

1 The discussion in this section is based on Kronick (2017) with an updated methodology and set of results. The basic conclusions remain the same.

Theory and Literature

The standard life-cycle permanent income hypothesis suggests that individuals will smooth consumption over their lifetime by using a single asset that can be lent or borrowed as they see fit. In this theory, consumption is driven by wealth and permanent income, and the size of the response to each variable is driven by the marginal propensities of each. There is no role for debt in this theory, but over time many have taken up the challenge, including studies by Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2011) and Hall (2011), who link debt and consumption through credit and liquidity constraints, opening up the theory to different specifications involving different debt variables.[2] Looking at Canada specifically, Muellbauer, St-Amant, and Williams (2015) show that, given credit conditions, the dominant effect of rising house prices relative to income is that it lowers consumption. The explanation is that, with higher housing prices relative to income, potential homeowners must save more for the necessary down payment. As access to mortgage credit improved during the late 1990s and into the 2000s, however – including through the introduction and growth of home equity lines of credit – the negative effect of house prices on consumption was dampened.

In general, the empirical literature finds mixed results regarding the effect on consumption of the appreciation of house prices relative to income. Two competing theories explain these divergent results (for a nice summary, see Albuquerque and Krustev 2015). The first is the more benign view of debt, in which households increase their indebtedness because they expect higher future incomes, leading to

2 Muellbauer (2008) also shows that the life-cycle permanent income hypothesis would show very little effect from a price-related increase in housing wealth on consumption if it did not include credit effects.

increased consumption. In this case, there is a positive relationship between consumption and debt. The second, more alarmist view is that high levels of debt constrain households, which are then forced to reduce consumption in order to improve their balance sheets. In this case, there is a negative correlation between consumption and debt.

Albuquerque and Krustev (2015) attempt to resolve these mixed results by expanding on the debt and consumption link and arguing that, to get a complete picture, one needs to study the effect of both deleveraging, as measured by decreases in the debt-to-income ratio, and the debt overhang, which is the stock of debt above an estimated equilibrium. We argue, however, that debt-servicing costs relative to other monthly expenditures are more important to households than is their debt-to-income ratio. In Canada, total and mortgage-only debt-service ratios over the period of our analysis – from the first quarter of 1990 to the third quarter of 2016 – have been relatively flat, despite rising housing prices across the country (Figures 12.1 and 12.2).[3] This flatness in total debt-servicing costs helps to explain why households have been willing to increase their debt-to-income ratio over this time.[4] This finding suggests that Canadians' decisions to take on more debt were appropriate. But what the total debt-servicing story fails to capture is the composition of that debt, in that the debt-servicing ratio has shifted from interest dominant to principal dominant (Figure 12.3).[5] This is not surprising, as

3 This remains true if one extends the graph to the end of 2017.

4 Non-mortgage debt servicing overtook mortgage debt as the larger contributor to total debt-servicing ratios in the late 1990s. On the whole, however, all measures were relatively flat.

5 Similarly, this also remains true if one extends the graph to the end of 2017.

interest rates fell during most of the period we analyze, causing house prices to increase.[6] The question then becomes: does this low-interest-rate, high-principal-debt dynamic increase household risk?

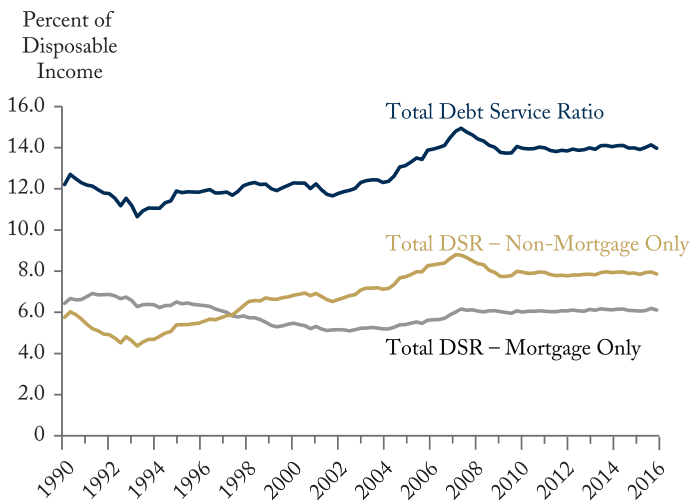
Risky Dynamics

Homeowners face three significant risks in a low-interest, high-principal environment. The first is increasing interest rates that lead to an unaffordable increase in debt-servicing costs. The second is a significant negative economic shock that leads to, or results from, falling house values, which might push mortgages under water. The third is mortgage tilt, which, in a low-interest-rate, low-inflation environment means consumers will not see as large a decrease in mortgage payments relative to income throughout their amortization period, affecting consumption decisions. We explore each in turn, but first we look at how economic theory might take these changing debt dynamics into account.

Assume there are two housing markets in which housing wealth is increasing. In scenario one, house prices are increasing at a robust pace, driven by strong demand and/or naturally tight supply – say, from geography constraining the building of single-family homes – plus other strong economic fundamentals such as increasing income. In this scenario, monetary policy and, therefore, interest

6 One potential caveat about the use of debt-servicing ratios comes from Brunnermeier and Julliard (2008) and the concept of money illusion. The argument is that households mistakenly assume that nominal and real interest rates move together, and therefore they attribute a decrease in inflation, as we saw in Canada over the period under analysis, to a decline in real interest rates. If that occurs, households will underestimate the real cost of paying for their mortgage down the line. This error creates upward pressure on housing prices, and contributes to increasing the principal component of the debt-servicing ratio. Our story so far omits this concern, but even if the ratio cannot inherently capture this feature, we argue that, if anything, this mistaken calculation reinforces the need to increase levels of precautionary savings as a result of the potential increase to aggregate risk.

Figure 12.1: Total Debt-Servicing Ratios (DSRs), Quarterly, Canada, 1990–2016

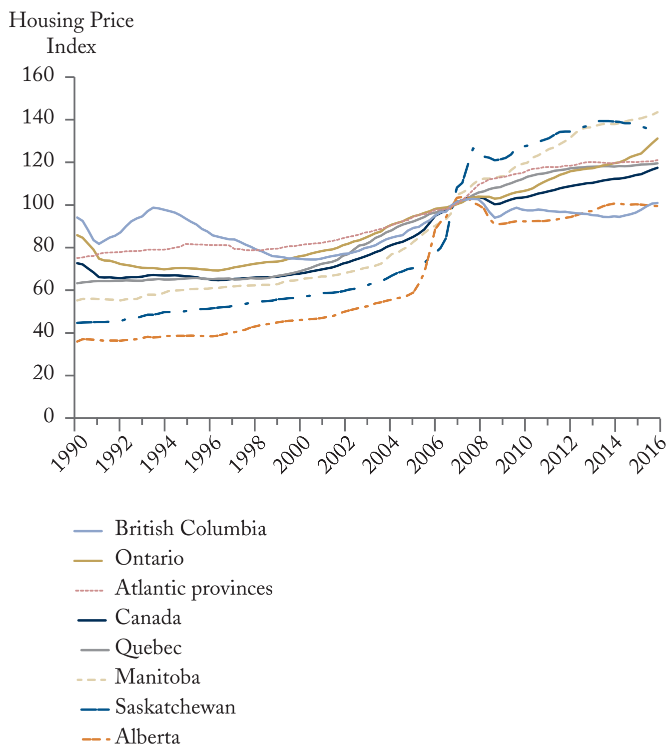


Source: Statistics Canada, CANSIM table 380 0073.

rates rise to keep pace with increasing inflation, and it is reasonable to expect a relatively flat debt-servicing ratio as income goes up to meet increases in house prices. More important, it is also possible that the gap between principal and interest payments remains the same as both house prices and interest rates rise.

In scenario two, which is similar to what we see now in some of Canada's frothy housing markets, high housing prices are the result of a combination of regulatory-induced tight supply – say, from a lack of infrastructure on otherwise developable land – interest rates that are low for long and non-economic fundamentals such as high levels of foreign demand. In this scenario, income growth might not keep pace with the increase in house prices. The result then

Figure 12.2: House Price Index, Quarterly, Canada and by Province, 1990–2016

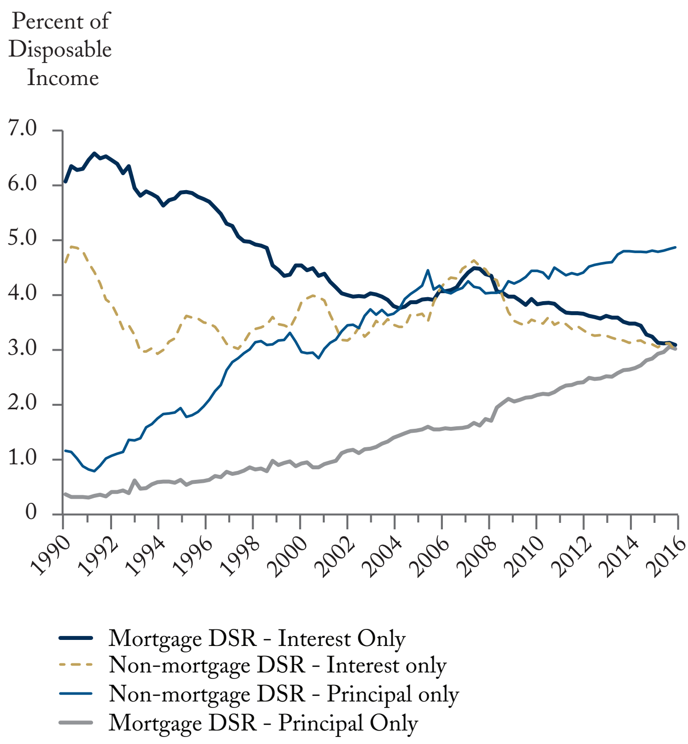


Note: 2007 = 100.
Source: Statistics Canada, CANSIM table 327 0046.

again could be a flat debt-servicing ratio, but now the gap between principal and interest payments would be skewed towards principal.

In both cases, housing wealth goes up, but the effect on the breakdown between principal and interest, and therefore on household risk, is vastly different. It is the latter scenario, however,

Figure 12.3: Interest and Principal Components of Debt-Servicing Ratios (DSRs), Quarterly, Canada, 1990–2016



Source: Statistics Canada, CANSIM table 380 0073.

in which Canadian households currently find themselves, that warrants household caution.

Increasing Total Debt-servicing Costs

With five-year mortgage terms the standard in Canada, many current homeowners will have to renegotiate mortgage rates multiple times over the amortization period of their mortgage. If this happens in an environment of interest rates that are higher than currently, households could face a financial challenge.[7] This would imply some precautionary savings upfront.

The source of the interest rate increase, however, is important in determining its effects on affordability. If the Bank of Canada increased its overnight target rate as a result of a growing economy – one that generates a positive output gap – consumers presumably would have additional income to support rising mortgage costs, and leverage fears would be at least partially mitigated. If the distribution of income gains as a result of a boom in economic activity are not widespread, however, or if they result in high-leveraged households receiving less of the income gains, an increase in interest rates would be detrimental to affordability.[8]

Additionally, macroprudential regulation on its own can cause financial institutions to increase mortgage rates without the Bank of Canada's changing the overnight rate. We saw that in 2016 following federal changes to mortgage rules, which increased costs to lenders and caused concern that the market faced potentially decreasing competition as lending was made harder for smaller financial institutions.[9] Therefore, even if the Bank keeps its overnight target the same, rates might still increase.

7 For those on variable rate mortgages, there is a short-run debt repayment constraint. If households are unable to borrow to compensate for changes in nominal mortgage rates, additional repayments (assuming the debt-to-income ratio is constant) cause a decrease in cash flows and therefore in consumption.

8 Unfortunately, data do not exist at the household level for the variables in this study. Our analysis would also improve if we had a provincial dataset that allowed us to run a more robust panel set that accounted for regional variances.

9 For example, in November 2016, one month after the new rules were announced, Royal Bank of Canada increased its three-year fixed rate by 25 basis points and its four- and five-year fixed rates by 30 basis points.

Mitigating some of the potential effects of increased rates has been the interaction between households' balance sheets and their ability to borrow in order to smooth interest-rate changes. In recent years, as access to mortgages has increased through home equity loans and lines of credit, smoothing consumption has become simpler for households. In this environment, changes in nominal interest rates have a reduced effect on consumption.

A Negative Economic Shock

The second major risk homeowners face is a negative economic shock that causes a recession. It is certainly true that, if a recession should hit, the Bank of Canada would not increase interest rates. However, if a housing price crash precipitates, or occurs as a result of, a fall in economic activity, wealth accumulated from housing price gains in the boom times might be lost.[10] This effect would be exacerbated by the fact that larger down payments have been required in the current environment meaning a greater concentration of wealth in one asset. Additionally, for households that have used wealth accumulated from increases in house prices for consumption the effects of the shock would be even more severe. Now seven years removed from the previous recession, we are likely closer to the next one than to the last.[11] Again, the implication is some form of precautionary savings.

10 Gordon (2015), ironically, in a piece on how household debt fears are exaggerated because of the use of stock and flow variables, still makes the point that "asset prices do have a large downside potential, and the illiquidity of housing assets is a serious concern for household finances." Flood, Morin, and Kolet (2008) also discuss the illiquidity of housing wealth due to high transaction costs.

11 Cross and Bergevin (2012) provide recession dating for Canada that ends in 2012, with no recessionary periods between 2009 and 2012. Although Canada has experienced one period of two recessionary quarters in a row since 2012, a diffusion index of Canadian industries indicates that the underlying negative economic shocks had no widespread effects (see Kronick 2016c). Thus, together with steady employment figures, this period cannot be called a recession.

Mortgage Tilt

The third risk to homeowners is mortgage tilt (see Schwab 1982). In a world of high inflation and high interest rates, as we saw in the 1990s, mortgage payments relative to disposable income are front loaded, and expectations of similar future levels of inflation lead to similar increases in wages to keep pace. Therefore, mortgage payments as a percentage of disposable income will go down throughout the mortgage's amortization period. If expectations are instead that inflation will fall, interest rates will fall as well, meaning mortgage renegotiations will occur at predominantly lower rates. Therefore, future mortgage payments relative to disposable income will again be lower later in the life of the mortgage amortization period.

Contrast those scenarios with today's low-inflation, low-interest-rate world. Mortgage tilt has all but disappeared, and as consumers look to the future, they expect inflation to be perhaps slightly higher than now, but not by much, since these expectations are fairly well anchored. So it seems likely that wages will continue to grow at a tepid pace. As a result, for most borrowers, mortgage payments relative to disposable income are unlikely to fall significantly over their mortgage amortization period.

All this is to say that mortgage repayment is harder today than it was for the previous generation. If households knew they will be able to afford more consumption in the future as housing costs fall relative to income, they might spend more today on non-housing consumption. Unfortunately, the more likely scenario is that households know they will be as constrained in the future as they are now, and will insulate themselves from negative shocks by tightening their belts on non-housing consumption today.

Testing Households' Reaction to Changing Debt Composition

With this riskier debt composition in mind, how can we test whether Canadian households' consumption has fallen as a reaction to the changing composition of the debt they hold? Statistics Canada now produces data on mortgage-debt-servicing ratios broken down by interest and principal costs. By taking the difference between the two ratios, we can see how the composition of debt is changing across time. We define this difference as the debt-servicing-ratio (DSR) gap.

As this DSR gap variable increases, interest makes up more of a household's monthly housing debt payments. As this difference shrinks, as it did for much of the period under analysis, households are more leveraged and potentially more vulnerable, with principal making up a larger share of monthly housing payments. To test this proposition, we use an error-correction model, largely based on Muellbauer, St-Amant, and Williams (2015). (In the appendices to this chapter, we present detailed discussions of variables and methodology, as well as our full regression results.) Since a shrinking DSR gap implies that the interest portion of a household's monthly debt costs is falling relative to the principal portion, a negative coefficient implies that households have actually increased consumption. The opposite is clearly true as well: a positive coefficient would imply a falling level of consumption and an increase in precautionary savings.[12]

We focus here on a subset of variables that will help us understand the effect that debt servicing has on non-housing

12 One potential issue with the DSR gap variable is that, although it is important to look at the repayment of debt and its relationship with consumption – and repaying debt means increases in housing equity – we look simultaneously at savers' recouping funds previously loaned. Since we cannot break consumption out between different cohorts of homeowners and households – for example, between outright owners and renters – we perhaps obtain some of the effect of the DSR gap variable on those who are doing the lending. One task for future research would be to follow in the footsteps of Campbell and Cocco (2007), who build regional and homeowner cohorts to study the causal effects of house price changes on consumption using household-level data from the United Kingdom's Family Expenditure Survey over the 1988–2000 period.

consumption. In Table 12.1, we run three regressions. Column 3 of the table is our preferred specification, where the coefficients come from running equation (12.6), as shown in Appendix 12B. Column 1 is a simplified version of this equation without the DSR gap variable and without a breakdown of assets into its component parts. Column 2 has the asset breakdown, but again does not include the DSR gap variable. The line in the middle of the table splits up the variables estimated in the long-run equation (top) and those estimated in the short-run equation.

Let us start with the simple long-run equation results in column 1. This is the classic solved-out consumption equation, where consumption is smoothed over a lifetime through an asset, which can be borrowed or lent, and expected future income. Both the coefficients on the ratio of net wealth to income and expected future income growth are significant and in the expected direction. When we look at the short-run results, however, the speed-of-adjustment term, at 5 percent per quarter, is both insignificant and far too low. This suggests that some omitted variables are at play. We also note the insignificance of the debt-servicing ratio variables in the short run, meaning that the composition of debt (principal versus interest payments) has no effect on short-run consumption behaviour.

In column 2 of Table 12.1, we break down homogeneous total assets into their respective parts. Doing this reduces the long-run expected forecast income growth to 0.7, which is in line with the results in Muellbauer, St-Amant, and Williams (2015).[13] The asset breakdown suggests a positive and significant result for financial assets and housing assets, which is to be expected, although it oddly produces a negative sign for net liquid wealth. Net liquidity generally declined, however, throughout the period under analysis, consistent with an environment of falling interest rates, thereby

13 A coefficient value of 1 would imply that a 1 percent increase in expected future income leads to 1 percent increase in consumption.

Table 12.1: Households' Reaction to Changing Debt Composition, Summary of Results

Dependant Variable: Consumption Growth	(1)	(2)	(3)
Forecast future income growth	0.832***	0.737***	0.682***
Net total HH wealth to income	0.0593***		
Net liquid wealth to income		–0.204***	–0.167***
Illiquid financial wealth to income		0.0195***	0.0147***
Housing wealth to income		0.0231**	0.0089
L.DSR GAP*			–0.010***
L.Real interest rate		–0.00273*	–0.00142
Speed of adjustment	0.0522	0.270***	0.298***
L.Debt-servicing ratio – mortgage	–0.256	–0.338	–0.479
L.Debt-servicing ratio – non- mortgage	–0.35	–0.26	–0.235
Current income growth	0.323***	0.318***	0.334***
Unemployment rate growth	–0.696**	–0.582**	–0.573**
Adjusted R2	0.362	0.444	0.452

Note: We used standard errors that are robust to heteroscedasticity in order to deal with any concerns over misspecification.

Source: Authors' calculations.

providing an incentive for borrowers to take out large loans on more illiquid assets. We do control for illiquid assets and housing wealth in our analysis, so perhaps it is a broader feeling of wealth that makes households consume more as they become less liquid. It does suggest, as well, that omitted variables are a concern. The short-run-equation results remain similar for almost all variables, including the insignificance of our measures of the DSR gap. The exception is the term indicating the speed of adjustment to equilibrium, which is much improved both in magnitude and significance. It is still a bit low, as it suggests a shock to consumption will dissipate in just under nine quarters, which is more than the one and a half to two years we expect it to take following a monetary policy event.[14]

In column 3, we add our lagged mortgage DSR gap variable to the long-run equation, and find that it is highly significant with a negative sign. Remember, as stated above, that a 1 percent increase in a DSR gap variable means debt consists more of interest than of principal. As the opposite was the case during most of the period under analysis, what we are really interested in is how a 1 percent decrease in the gap variable affects consumption. Therefore, a negative coefficient implies that consumption increases as the particular gap variable declines. Before we explain why, let us first see how adding the lagged mortgage DSR variable to the long-run equation affects the other variables in both the short and long run.

In the long run, expected future income growth remains around the 0.7 coefficient mark. The ratio of illiquid financial assets to income is still highly significant, and net liquid assets are still negative. Surprisingly, housing wealth loses all of its significance. The reasons for this and for why the DSR gap coefficient is negative are one and the same, as we will see. As for the short-run coefficients, the speed-of-adjustment term is now close to 0.3, meaning it now

14 This calculation uses the half-life equation and 90 percent as the target for the shock to dissipate.

sits below eight quarters for 90 percent of the shock to dissipate, in line with our expectations. The short-run DSR variables remain insignificant. We note also that, of the three equations, the adjusted R-squared is the highest when we include the DSR gap variable in the long-run equation.

As for the explanation of the DSR and housing wealth results, as we discussed above there are two scenarios in which housing wealth increases as a result of increases in housing prices. The first involves strong economic fundamentals, leading to increases in housing and aggregate demand, causing robust economic growth and rising interest rates in response to inflation above target. In this case, housing wealth increases, but the DSR gap might remain stable as increases in house prices and, therefore, higher principal on debt – assuming down payment sizes remain relatively the same – are met with increases in interest rates. The second scenario involves increases in house prices as a result of low interest rates and other non-economic fundamental factors, such as regulation that artificially restricts supply or the ease with which foreigners can buy housing in Canada. In this case, housing wealth might be the same, but the principal component of debt-servicing costs would outstrip the interest component, leading to a falling DSR gap variable. Therefore, it is the DSR gap measure that should matter for assessing housing wealth, which is exactly why it cannibalizes the effect of housing wealth itself.[15]

Conclusion and Policy Implications

What monetary policy implications arise from Canadian households' not having adjusted their consumption behaviour with the changing composition of their mortgage debt? Although the Bank of Canada

15 The lack of significance of the housing wealth variable is also true of the consumption equation results found in Muellbauer, St-Amant, and Williams (2015).

has a clear mandate to target 2 percent inflation, a medium-term objective, it is obviously useful to understand the host of potential household reactions to interest-rate movements and economic shocks. As a way of thinking through the policy implications, let us use our three additional risks from principal-heavy debt.

The lack of the interest rate's significance in the long-run equation and the insignificance of the DSR gap variables in the short-run equation suggest that changes to the interest rate are unlikely to cause as much consternation as perhaps believed.

Given the size and significance of the forecast income growth coefficients, mortgage tilt might turn out to be a serious concern. If wage growth continues to be tepid and households adjust to slower future income growth, non-housing consumption might fall as a result.

That said, the biggest concern for the Bank of Canada might be the size of the effect of an economic shock that brings down housing values. Any negative economic shock will affect income and unemployment and, therefore consumption, which we see in the short-run equation. In light of outsized leverage from a housing market driven less by economic fundamentals than by low interest rates, no precautionary savings – that is, a negative coefficient on the DSR gap variable – will exacerbate the normal fall in economic activity. This larger-than-normal affect might generate a deeper fall in output, and therefore require a more significant stimulus on the part of monetary policy. As we are now seven years removed from the most recent recession, we are likely closer to the next one than to the previous one. If the next recession is deeper than expected, the Bank might have to turn to unconventional monetary policy quicker than it otherwise would. Should that occur, we favour non-temporary quantitative easing and permanent, predefined, emergency liquidity facilities.

Changing Demographics and Monetary Policy

As we discussed in Chapter 7, the recovery from the Great Recession has been slow and painful in Canada and abroad. Inflation has been tepid in many countries, despite rock-bottom interest rates and the use of different forms of unconventional monetary policy, including quantitative easing. In Canada, inflation has averaged a little over 1.6 percent since 2010. One reason for the slow recovery is a fall in the long-term neutral rate of interest, which makes it more difficult for the central bank to boost demand and inflation by lowering the policy rate below the natural rate of interest.

Both lower economic growth and lower population growth are partly responsible for the lower neutral rate of interest (see IMF 2012). In addition, the changing age structure of the population itself can have an important effect on how monetary policy changes are transmitted to the economy, because different age cohorts react differently to changes in interest rates. For example, there is significant evidence to indicate that changing demographics in Canada, Germany, Japan, the United Kingdom and the United States have weakened the effect of monetary policy in those countries over time (Imam (2015). This result is even more concerning given that the relationship between the level of economic activity and inflation also seems to have weakened gradually over the past 30 years. In academic circles, this if often referred to as a flattening of the Phillips curve, and has been shown to be common across most industrialized economies. What it means to central banks is that, to affect inflation rates, they must affect aggregate demand and output even more than before.[16]

16 Carney (2017) notes that economies have become more open and the nature of international trade has changed, with global value chains boosting trade in intermediary goods; he also claims that inflation has become a much more globalized phenomenon since the financial crisis.

Our main goal for the remainder of this chapter is thus to look more closely at the Canadian evidence. Imam (2015) looks at Canadian data at the aggregate level, and the availability of some of his time series at the provincial level and an improved monetary policy shock series allow us to look at the effectiveness of Canadian monetary policy in more detail.

Channels for Monetary Policy Effectiveness

Demographics affect monetary policy through three primary transmission channels: the interest rate channel, the credit channel and the wealth channel (Imam 2015; see also Mishkin 1996).

The interest rate channel follows from the life-cycle hypothesis (Modigliani 1966). The essential idea is that households accumulate debt as they go through the early stages of adulthood, but they are able to pay off this debt as they age, and they end up as creditors by the time they hit life's later stages. For this reason, younger households are more sensitive to changes in interest rates than are older households since they need more credit. In this case, monetary policy has a reduced effect on an aging population.

In many ways, the credit channel is related to the interest rate channel. As households age, they have higher net worth and significantly more collateral. It is therefore cheaper for them to borrow should they need to – to economists, this is known as having a lower external finance premium. The smaller this finance premium the less sensitive households are to monetary policy. Young adults have a higher external risk premium. Once again, the implication is that monetary policy has a reduced effect on an aging population.

Although the interest rate and credit channels work in the same direction – aging leads to less-effective monetary policy – the wealth channel has the opposite effect: as the population ages, it tends to own more assets and have greater net worth. The more assets households have the more sensitive they are to changes in interest rates. The effect is exacerbated, moreover, because these assets tend to be fixed-income products that, by their very nature, are sensitive to interest rates. We therefore expect monetary policy to generate larger real economy effects through the wealth channel.

The Changing Effectiveness of Monetary Policy

To test the effect of demographics on monetary policy, we followed Imam's (2015) empirical methodology,[17] and we highlight a few findings here to help the reader interpret the results and understand the implications for monetary policy.

The first stage of the analysis involves determining how monetary policy effectiveness evolved over the period from the second quarter of 1985 to the fourth quarter of 2015. Crucial to this analysis is a proper identification of the exogenous monetary policy shock variable. Imam's results for Canada show a significant delay in the drop in prices following a contractionary monetary policy shock. This price puzzle is consistent with other studies (see, for example, Kim and Roubini 2000) in which monetary policy shocks are identified using innovations in policy rates in a vector autoregression (VAR) setup. A more successful method of identification of an exogenous monetary policy shock involves using the narrative approach pioneered by Romer and Romer (2004). This method uses minutes of US Federal Open Market Committee (FOMC) meetings to generate a time series of intended changes to the Federal Funds Rate. The minutes are necessary since the FOMC does not always explicitly target the Federal Funds Rate. In Canada, we are lucky in that the Bank of Canada has always used an explicit target, and thus we can see the intended rate change simply by evaluating how the overnight rate target differs from one meeting to the next.

17 We describe the methodology in detail in a companion working paper; see Kronick and Ambler (2017).

The next step is to extract the exogenous part of the intended rate change from the more systematic component, which is estimated by what one considers to be the central bank's reaction function. We are also lucky here, as Champagne and Sekkel (2017) have done this investigation for the Bank of Canada and generated the appropriate dataset. We go into greater detail on how they do this in our working paper (Kronick and Ambler 2017); suffice it to say that the Bank's reaction function, according to Champagne and Sekkel, consists of:

- one- and two-quarter-ahead forecasts of real output growth and inflation;
- nowcast[18] and the real-time one-quarter lag of these variables;
- revisions to the forecasts relative to the previous round of forecasts;
- the intended policy rate two weeks before the meeting; and
- the unemployment rates over the previous three months.

Champagne and Sekkel's big departure from Romer and Romer's reaction function is that they also control for lagged levels and changes of the Federal Funds Rate and the lagged nominal exchange rate between the US and Canadian dollars.

Once we have this set of shocks, we can move to a simple system of equations including inflation, the unemployment rate, and the shock series, in that order. Generally, variables in structural vector autoregressions are non-stationary, so the shock series – which is stationary – is cumulated to make it consistent. We departed, however, from Champagne and Sekkel (2017) in a couple of different ways. First, we ordered the shock variable ahead of inflation and unemployment, instead of after. We did this because, if the shock is identified properly and the Bank of Canada follows its own mandate of targeting inflation in the medium term, there should be

18 A nowcast involves estimating the current value of a quantity such as GDP whose true value is only published after a considerable delay, and even then often with revisions.

no contemporaneous effect of inflation and unemployment on the shock series.[19] Second, we differed from Champagne and Sekkel in terms of the variables that we believe affect the monetary policy shock variable contemporaneously. Like Champagne and Sekkel, we added the Bank's commodity price index (ordered first), but we also added the Federal Funds Rate ahead of the shock because, although the reaction function incorporates a lagged Federal Funds Rate, at a quarterly frequency we believe US monetary policy has contemporaneous effects on the Bank's monetary policy decisions.

In our analysis, we allowed the coefficients relating unemployment and inflation to Canadian monetary policy to vary systematically over our study period (the second quarter of 1985 to the fourth quarter of 2015).[20] This methodology is critical for anyone interested in evaluating slow-moving, smooth and long-term economic variables such as demographics, as we do in the second stage.

This stage-one analysis, performed on Canada and all provinces, gave us our dependent variables for stage two. These dependent variables can be thought of as a time series of monetary policy effectiveness in Canada, measured by the maximum and cumulative values of inflation and unemployment following a monetary policy shock.[21]

19 We note that the authors do check this for robustness, and find no change to the results. However, as provincial inflation and unemployment do not tend to factor directly into monetary policy decisions, we order them after the shock.

20 We used Bayesian estimation techniques, so technically this is a time-varying coefficient Bayesian structural vector autoregression; see Kronick and Ambler (2017) for the technical details.

21 We do not include monetary aggregates. Although we are sympathetic to their importance to monetary policy, their addition would add more required estimated coefficients, and the literature has largely moved away from using them in identification (see, for example, Cushman and Zha 1997).

Results

We detail the individual provincial results for stage one in our companion working paper (Kronick and Ambler 2017), but for brevity we focus here on the aggregate Canadian results, summarized graphically in Figures 12.5 and 12.6 in Appendix 12D. The impulse response functions (Figure 12.5) indicate the response of inflation and unemployment to a one-percentage point innovation in the Bank of Canada's policy rate. The confidence bands and the gold line that gives the point estimate of the response are for the first quarter in the sample: the second quarter of 1985. The remaining point estimates show the evolution of the effect of a monetary policy shock at five-year intervals. The peak effect graphs (Figure 12.6) show the largest fall (rise) in inflation (unemployment) from a contractionary monetary policy shock (with confidence interval) across our time period.

As we go through these results, the reader should keep in mind that a greater fall (or rise) in inflation (or unemployment) across time indicates increasing monetary policy effectiveness following a contractionary monetary policy shock. The results are also symmetric if one prefers thinking of an expansionary monetary policy shock.

The peak effects of a monetary policy shock on both inflation and unemployment are significant across time, but with barely any changes in the magnitudes of both. The peaks of the two variables occur approximately when we would expect from a transmission perspective: anywhere from 6 to 11 quarters after the monetary policy shock occurs. The cumulative effect is harder to tell from the graphs, but it turns out that we have seen a bit of an improvement in the size of the response of inflation to a contractionary monetary policy shock and a mild worsening in the response of unemployment.

These mixed inflation results are consistent with the fact that, on the one hand, inflation-targeting central banks have been more successful by many metrics, including lower variability of inflation and lower inflation levels; as well, however, firmer expectations have made it more difficult for policy changes to have the same effect on inflation. Unfortunately, when focusing on Canada's low-growth post-crisis economy, monetary policy has lost some of its effectiveness using as a metric either maximum or cumulative changes in inflation. This confirms the results of other studies for a wide range of countries (see, for example, Borio and Hofmann 2017).

To summarize, whether monetary policy has become more effective (as measured by maximum or cumulative changes to inflation/unemployment) is unclear. Although it is important to continue to evaluate this aspect, the primary question we answer in this part of the chapter is the role demographic change has played in the effect of monetary policy on these key macroeconomic variables.

The Effect of Demographics

To help answer this question, we used a dynamic ordinary least squares panel regression analysis (for more information, see Kronick and Ambler 2017). We took our measures of monetary policy effectiveness by province from the previous section as dependent variables in a series of regressions, and tested our results on four different dependent variables: maximum inflation, maximum unemployment, cumulative inflation and cumulative unemployment.

A positive monetary policy shock (an increase in the overnight rate) leads to a decrease in inflation and an increase in unemployment. We calculated the maximum responses (in absolute value) of inflation and unemployment as well as the cumulative effects (again in absolute value) on inflation and unemployment. These calculated effects became our dependent variables for the second-stage regressions. For notational purposes, we label this variable $effect_{it}^{j}$, where i represents the different provinces in the panel, t is time and j separates when we are looking at inflation rather than unemployment – and, for that matter, maximum rather than cumulative; see Appendix 12E for the full formal regression.

The explanatory variables we used, similar to those of Imam (2015), are the old age dependency ratio, manufacturing output relative to total output, a measure of the economy's openness to the rest of the world and a measure of the importance of private sector credit. We are interested primarily in the effects of demographic change, but we used the other variables in the regressions as controls to avoid biased results from omitted variables. Imam also includes the share of smaller firms to total firms in an economy, which we were unable to do as a result of the lack of data at the provincial level.

The use of the old age dependency ratio as our demographic variable reflects an assumption that the behaviour of different age cohorts is relatively constant over time. We checked this assumption by analyzing data on the cross-cohort behaviour of assets and debts in Canada in 1999, 2005, 2012 and 2016. In all four years, debt peaked for individuals ages 35 to 44, while assets peaked for those between 55 and 64. Our interpretation is that the change in age distribution matters; in other words, what is important is the changing relative sizes of different age cohorts over time.

Since our purpose is to determine what effect aging has had on the effectiveness of monetary policy, we needed to drill down further on this measure of changing demographics. We started by using CANSIM table 282-0087, and subtracted those ages 15 to 64 from those ages 15 and older to calculate those ages 65 and older. We then divided this number by those ages 15 to 64 to get the old age dependency ratio – similar to Imam (2015) at this point. In simple terms, this ratio represents the number of elderly relative to the working-age population.

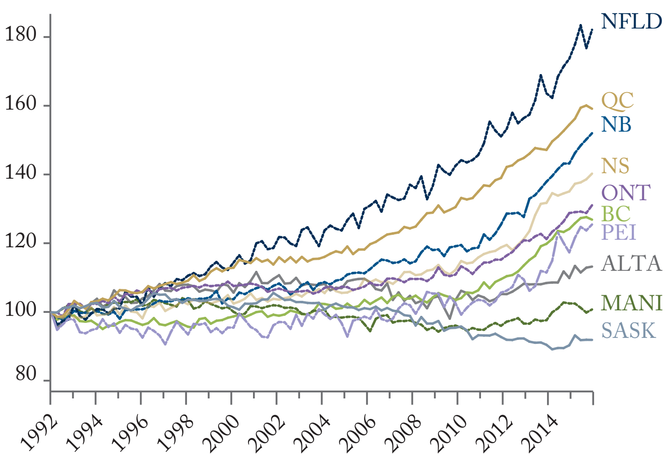
The problem with this variable is that it arbitrarily sets age 65 as "old." There are reasons to use this cutoff – for example, because the retirement age in Canada is 65 – but one way to reduce its arbitrariness is by subtracting those ages 65 and older who are still in the labour force from the number of dependents. As Figure 12.4 shows, this new ratio has steadily increased on balance over the period under analysis in all provinces except Saskatchewan. Quebec and the Atlantic provinces have experienced particularly large increases in the old age dependency ratio.

Primary Results

We give the estimated equation in Appendix 12D, along with our basic formal panel regression results, and Table 12.2 shows a simplified version of our results. Due to lack of data, we estimate the equation using a sample period of the first quarter of 1992 to the fourth quarter of 2015. The monetary shock that we model in stage one is a 1 percent increase in the Bank of Canada's policy rate, which has a negative effect on inflation and a positive effect on unemployment. Accordingly, a positive (negative) sign in the table means that the relevant variable reduces (increases) the effectiveness of the policy change on inflation and increases (reduces) its effect on unemployment.

The results for all four dependent variables are broadly consistent with those of Imam (2015) in direction and significance, although with smaller magnitudes. The key result for our purposes is that an aging population does appear to reduce the effectiveness of monetary policy on both inflation and unemployment, with the effect stronger on unemployment. The results are consistent for unemployment whether we use cumulative or maximum as the dependent variable. With inflation, the effect is statistically significant only when we look at maximum inflation. The more mixed results for inflation are consistent with the anchored-inflation expectations that have become more widespread since the Bank of Canada became an inflation-targeting central bank.

Figure 12.4: Old Age Dependency Ratio by Province, Quarterly, 1992–2015



Note: 1992:Q1 = 100. The figure is an index that normalizes all of the series to 100 at the start of the sample. In the regressions, we used the dependency ratios without normalization.
Sources: Authors' calculations; Statistics Canada, CANSIM table 282 0087.

We also note that, although the standard 1 percent increase in old age is an appropriate way of analyzing the question at hand, perhaps more interesting, given the slow-moving nature of demographics, is the effect of the entire increase in age of Canada's population on the effectiveness of monetary policy over our study period. In the country as a whole, the old age dependency ratio increased by 33.8 percent, and monetary policy effectiveness, as judged by maximum inflation, fell by 0.115 percent (33.8 × 0.00341), or approximately 12 basis points. So, if the average maximum fall in inflation from a contractionary monetary policy shock was 0.40 of

Table 12.2: Impact of Macroeconomic Variables on Monetary Policy Effectiveness

1 Percent Increase in:	Results in Following Percentage Change in Effect of Increase in Policy Rate on:			
	Cumulative Inflation	Cumulative Unemployment	Maximum Inflation	Maximum Unemployment
Old age	–0.029	–0.059 (**)	0.003 (**)	–0.006 (***)
Manufacturing	0.092(***)	0.218 (***)	0.008 (***)	0.0141 (***)
Private credit	–0.039(***)	–0.015(***)	–0.002 (***)	–0.0001
Openness	0.002	–0.008 (*)	0.0004	–0.0001

Note: * marginal significance at the 10% level, ** marginal significance at the 5% level, *** marginal significance at the 1% level; analysis is for the period 1992:Q1 to 2015:Q4.

Source: Authors' calculations.

a percentage point across time and across provinces over the period of our analysis, it would have fallen 0.52 of a percentage point if not for an aging population. Given the insignificance of an aging population on cumulative inflation, we did not perform a similar analysis on this variable.

Looking at unemployment, multiplying 33.8 by the coefficients on cumulative and maximum unemployment gives us –1.994 and –0.204, respectively. Therefore, an expansionary monetary policy shock at the beginning of our sample that lowered the unemployment rate by 1.994 percentage points would have no effect today. Similarly, the peak decrease in the unemployment rate from an expansionary shock today is 0.204 of a percentage point lower than it was in 1992.

Control Variables

What about our control variables? We find that an economy with a higher concentration of manufacturing causes greater unemployment sensitivity in response to monetary policy shocks. This is consistent with the idea that the manufacturing sector tends to be more interest-rate sensitive (see, for example, Carlino and Defina 1998). Consistent with the finding of Imam (2015), this result does not hold for inflation sensitivity.

The results also indicate that a more open economy has no significant impact on monetary policy effectiveness. Even in the one case where there is some weak significance, the magnitude is so small that we consider it negligible. The insignificance can be explained by two opposing considerations. On the one hand, an increase in interest rates will cause an appreciating exchange rate, which, for a more open economy, should lead to a greater fall in inflation and a larger increase in unemployment. On the other hand, increased global trade integration might actually weaken the linkages between monetary policy and key macroeconomic variables (Poloz 2016). In large part this is because domestic inflation is affected more by global demand and supply than by changes in domestic behaviour. China's ascension in the global market and the collapse of trade during the Great Recession are both examples of significant international macroeconomic events that had ripple effects domestically, and the challenge is to figure out how inflation responds in this newer environment and how central banks should react.

Finally, the coefficients on private credit tell a somewhat mixed story. For the regressions with inflation as dependent variables, we get consistently significant and negative coefficients. This is consistent with the idea that more credit present in the Canadian economy leads to increased sensitivity to changes in the interest rate, which then have a greater effect on spending and inflation.

For unemployment, the results are either insignificant or indicate a mildly less sensitive real economy. One possible explanation for this counterintuitive result is that Canada has experienced mostly expansionary monetary policy over the period we looked at, and the more credit constrained individuals are the less space they have in their budgets to borrow and spend when interest rates come down. If that occurs, there is less of an increase in aggregate demand, less economic growth and a more attenuated unemployment rate. This explanation should lead to lower inflation as a result of reduced spending, but if the spending that did occur went to parts of the economy that experienced above-average inflation – for example, housing – then both effects could apply simultaneously.

The key takeaway from the primary results is that Canada's aging population is acting as a drag on monetary policy effectiveness. Below we look at the transmission mechanisms that are responsible for these results, but we ask readers to focus on this demographic drag when we discuss policy implications for the Bank of Canada.[22]

Transmission Mechanisms

Having determined that an aging population acts as a drag on monetary policy effectiveness, the next logical question is why? What is happening in the economy that causes this phenomenon? To answer, we used two empirical regression techniques to test the importance of the interest rate and credit channels. Unfortunately, we did not have access to wealth data at the provincial level, only at the national level. As we have mentioned, however, cross-sectional and time series variation in the data are both needed to evaluate properly very slow moving variables such as aging.

22 As robustness checks, we experimented with, among other things, different leads and lags in our panel regression, as well as the removal of some outlier periods in some of our control variables. The results did not change materially from our base case regression (see Kronick and Ambler 2017).

We tested the effect of the interest rate and credit channels together since they are so closely linked. The first technique involved removing the private credit control variable from the primary regression; the second involved interacting the private credit variable with the old age variable. Table 12.3 shows the results for the variable removal technique. For inflation, removing private credit leads to old age's appearing to have a positive impact on monetary policy effectiveness. This is precisely what we would expect, since an increase in credit on its own – that is, not accounting for aging – should cause an increase in monetary policy effectiveness as higher debt loads mean more sensitivity to interest-rate movements, which funnels down towards household spending and, therefore, inflation. When we removed this variable, its correlation with the age pyramid caused it to affect the coefficient on old age in the direction of increased sensitivity. What this implies, though, is that, if not for aging, monetary policy would have been more effective through its effect on credit.

For unemployment, we also see an effect from the removal of private credit, although this time there was a further decrease in the effectiveness of monetary policy as a result of old age. This is consistent with the discussion above on credit-constrained households in our environment of decreasing interest rates, which appears to exacerbate the already-decreasing effect on unemployment from old age.

Table 12.4, which shows results for the variable interaction technique, is trickier to understand. The way to interpret the role of old age is to add the coefficient on old age to the interaction coefficient, multiplied by some value of private credit – in our case, we took the mean. We then obtained coefficients that essentially match the primary results across the board. What is relevant is that, with the exception of the cumulative inflation regression, the interaction terms are significant in all cases, highlighting the link between credit and old age. The insignificance of the interaction

Table 12.3: Transmission Mechanism, Removal Technique

1 Percent Increase in:	Results in Following Percentage Change in Effect of Increase in Policy Rate on:			
	Cumulative Inflation	Cumulative Unemployment	Maximum Inflation	Maximum Unemployment
Old age	–0.089 (***)	–0.082 (***)	–0.0003	–0.006(***)
Manufacturing	–0.051 (***)	0.202 (***)	0.005 (***)	0.014 (***)
Openness	0.010 (***)	–0.005	0.001 (***)	–0.0001

Note: * marginal significance at the 10% level, ** marginal significance at the 5% level, *** marginal significance at the 1% level; analysis is for the period 1992:Q1 to 2015:Q4.

Source: Authors' calculations.

coefficient in the cumulative inflation regression is consistent with the insignificance of old age for this same regression in our primary specification. The bottom line is that these results are further evidence that the interest rate and credit channels play important roles as transmission mechanisms.

Policy Implications and Conclusions

Canada's inflation-targeting policy framework is in reasonably good shape, but it is not perfect. A lower neutral interest rate means that the Bank of Canada must start from a lower neutral position, meaning it has less room to reduce rates before hitting the zero (or small negative) lower bound. Future crises and/or recessions, therefore, would force the Bank to resort to unconventional monetary policies sooner. If further population aging reduces the

Table 12.4: Transmission Mechanism, Interaction Technique

1 Percent Increase in:	Results in Following Percentage Change in Effect of Increase in Policy Rate on:			
	Cumulative Inflation	Cumulative Unemploy-ment	Maximum Inflation	Maximum Un-employment
Old age	–0.034	–0.391(***)	0.013(***)	–0.033(***)
Manufacturing	0.093 (***)	0.238 (***)	0.007 (***)	0.016 (***)
Private Credit	–0.039(***)	–0.156 (***)	0.002 (*)	–0.012 (***)
Openness	0.002	–0.008 (**)	0.0004 (*)	–0.0001
Interaction	–0.0001	0.008 (***)	–0.0002(***)	–0.0006(***)

Note: * marginal significance at the 10% level, ** marginal significance at the 5% level, *** marginal significance at the 1% level; analysis is for the period 1992:Q1 to 2015:Q4.

Source: Authors' calculations.

effectiveness of monetary policy, this eventually could undermine the inflation-targeting regime.[23]

Canada's aging population has indeed acted as a drag on monetary policy effectiveness, and is likely a leading cause of the systematic undershooting of inflation since the financial crisis. The interest rate and credit channels help explain this result – specifically, an aging population that takes on less debt is less sensitive to changes in the interest rate. This means that hitting the inflation target will require the Bank of Canada to make more

23 We acknowledge that fiscal policy and immigration policy can also affect the impact of population aging on macroeconomic variables, as one reviewer suggested, but our focus here is on monetary policy.

significant changes to the overnight rate target and, in the case of expansionary monetary policy, the task will be made more difficult by a lower neutral rate of interest, which might result in the Bank moving more quickly to adopt unconventional policies, including a greater focus on monetary aggregates. Our results should help the Bank adjust its analysis accordingly.

Appendix 12A: Variable Descriptions and Statistics

The non-housing consumption variable we use in this study is Statistics Canada's real household final consumption expenditure (CANSIM table 380-0067), with housing services subtracted. This variable is available quarterly, and is seasonally adjusted at annual rates. Where possible, we adjusted variables seasonally at annual rates; if these were unavailable, we controlled for any omitted time-related factors by using quarterly and time dummies. The DSR gap variables – mortgage and non-mortgage – come from CANSIM table 380-0073, as does the total mortgage debt-servicing ratio; the principal component is not in the table, but can be calculated as a simple subtraction of the interest component from the total. The present value of permanent disposable income uses household income (also from CANSIM table 380-0073) to calculate the discounted sum of forward-looking households with perfect foresight 40 quarters (10 years) in the future:

$$\ln{(y_t^p)} = (\sum_{s=1}^{k}(\delta^{s-1}\ln(y_{t+s}))/(\sum_{s=1}^{k}(\delta^{s-1}))). \qquad (1)$$

We weighted this variable by current income, as in Muellbauer, St-Amant, and Williams (2015), to get the following formula:

$$\ln{(y_t^p/y_t)} = (\sum_{s=1}^{k}\delta^{s-1}\ln(y_{t+s}))/(\sum_{s=1}^{k}\delta^{s-1}) - \ln(y_t). \qquad (2)$$

The discount rate δ used is 0.95, and to extrapolate beyond the third quarter of 2016, we calculated a 0.2 percent growth rate, both consistent with Muellbauer, St-Amant, and Williams (2015).

The issue so far with this variable is it that assumes perfect foresight. This is obviously unrealistic. So to relax this assumption, again following Muellbauer, St-Amant, and Williams, we used a forecasting model that relies on the fact that deviations of the log of permanent income to current income can be explained by deviations of the log of current income around a trend, as well as by a set of forward-looking variables that include the log of real income, a trend variable, the log of a four-quarter moving average of terms of trade, the log of the ratio of the working-age population (ages 15–64) to the total population, the four-quarter change in chartered banks' conventional five-year fixed mortgage rates and lags of one-quarter changes of the log of real income. The fitted variable of forward-looking income growth rates now represents household expectations.[24] Unemployment comes from Statistics Canada's Labour Force Survey (CANSIM table 282-0087). The loan-to-value ratio (used in sensitivity/robustness) is a bounded variable that takes on the policy rule in place at a particular point in time for first-time homebuyers. The timing of the changes comes from Kronick (2016a), based on public information.

We followed the exact definitions in Muellbauer, St-Amant, and Williams (2015) for the following variables:

- the credit conditions index (used in sensitivity/robustness);
- the real household borrowing rate;
- the ratio of net liquid assets to income;
- the ratio of illiquid financial assets to income; and
- the ratio of housing assets to income.

We departed slightly from these authors' definition of the child-to-adult ratio (used in sensitivity/robustness), first, by using data from Statistics Canada data, rather than from the OECD as they do, and second, we shortened the moving average period to be subtracted from 30 years to 20 years. Table 12.5 contains descriptive statistics.

24 Estimates of the household-income-forecasting equation are available from the authors upon request.

Table 12.5: Descriptive Statistics, 1990:Q1 to 2016:Q3

	Mean	SD	Min	Max
Consumption/income ratio	3.991	0.0593	3.865	4.058
Credit conditions index	46.04	6.060	39	60.3
Loan-to-value ratio	95	1.943	90	100
Net total wealth to income	3.945	0.9799	2.198	6.051
Real interest rate (percent)	6.743	1.987	3.623	13.604
Net liquid assets/income	–0.1499	0.1774	–0.3712	0.1117
Illiquid financial assets/ income	2.054	0.4406	1.109	2.904
Housing assets/income	1.974	0.4690	1.254	2.920
Expected future income growth (percent)	0.0748	0.0288	0.0174	0.1208
Debt-servicing ratio gap	3.164	1.740	0.07	6.24
Child/adult ratio	–0.052	0.200	–0.1431	0.6613
Consumption growth (percent)	0.6384	0.7870	–2.923	2.095
Debt-servicing ratio gap growth (percentage points)	–0.0531	0.1358	–0.6300	0.3300
Debt-servicing ratio gap growth (non-mortgage) (percentage points)	–0.0502	0.1966	–0.45	0.7
Income growth (percent)	0.5019	0.7577	–2.712	2.811
Unemployment rate growth (percentage points)	–0.0057	0.2985	–0.6000	1.2

Note: 107 quarterly observations.

Source: Authors' calculations.

Appendix 12B: Detailed Methodology

We started with the solved-out life-cycle permanent income hypothesis:

$$c_t = \frac{1}{\omega} W_t = (\gamma^* A_{t-1} + y_t^p). \qquad (3)$$

Linearizing in logs gives

$$\ln(c_t/y_t) \approx \alpha_0 + \gamma A_{t-1}/y_t + \psi E_t \ln(y_t^p/y_t). \qquad (4)$$

This latter equation states that the log-consumption-to-income ratio is made up of three parts: a time-invariant consumption share, α_0; the ratio of net household wealth, lagged by one period, to current income, A_{t-1} / y_t scaled by the marginal propensity to consume out of this wealth, γ; and the expected log ratio of permanent income to current income, $E_t \ln(y_t^p / y_t)$, scaled by ψ in order to generalize the permanent income hypothesis.

Using our definition of the expected permanent income ratio from Appendix 12A, and doing some rearranging, gives us:

$$\begin{aligned} \Delta \ln(c_t) \approx \varphi(\alpha_0 + \gamma A_{t-1}/y_t + \psi E_t \ln(y_t^p/y_t) + \\ \ln(y_t/c_{t-1})) + \lambda \Delta \ln(y_t), \end{aligned} \qquad (5)$$

where φ is the speed of adjustment term, and $\Delta \ln(y_t)$ is the change in log current income.

First, we estimated this regression. Then we augmented it reflecting the work and findings in Albuquerque and Krustev (2015) and Muellbauer, St-Amant, and Williams (2015). First, by estimating a regression where assets are broken down in terms of their liquidity and credit access. Namely, we broke down A_{t-1} / y_t into NFA_{t-1} / y_t, the ratio of net liquid assets (cash and cash-like assets less household debt) to income, IFA_{t-1} / y_t, which is the ratio of illiquid financial assets (financial assets less liquid assets) to income, and HA_{t-1} / y_t, the ratio of gross housing assets to income.

Next, we followed Albuquerque and Krustev (2015) and added debt variables to our long-run equation, with a focus on the mortgage-debt-servicing-ratio variable. We did not include the non-mortgage-debt-servicing-ratio variable as its effect on consumption likely occurs in the short run. This is especially true in Canada where the magnitude of credit card debt use, and its effect on economic variables, is difficult to assess. The reason is the disproportionate incentives (relative to other countries) to use credit cards on even routine purchases. The incentives come from the fact that the Interac debit network is controlled by banks, so credit card companies often do not offer debit usage on their cards, as they do, for example, in the United States, instead offering better incentives to use the credit portion of their cards. What this means is that more-creditworthy people use their credit cards more often, leading to high non-mortgage debt but very low default rates (see Zelmer and Kronick 2018). So, although changes to the non-mortgage DSR gap might affect short-run non-housing consumption decisions by less-creditworthy users, the preponderance of creditworthy users makes it unlikely that similar changes would have any long-run effects.

As in Muellbauer, St-Amant, and Williams (2015), the short-run equation includes lagged consumption growth, current income growth, current unemployment growth and a differenced dummy for the temporary change in consumption as a result of the introduction of the goods and services tax on January 1, 1991. In addition to lagged growth in the short-run non-mortgage-debt-servicing ratio, we also added the lagged short-run growth in the mortgage-debt-servicing ratio.

All variables are quarterly and the differences are quarter-over-quarter.

Stationarity tests revealed that all level variables are integrated of order 1 – that is, they need to be differenced to be stationary, except for the loan-to-value ratio (Table 12.6). Furthermore, the Johansen tests for cointegration show that there is, indeed, cointegration among the variables and, specifically, the presence of one cointegrating relationship in our primary specification (column 3 of Table 12.1). This cointegrating relationship justifies our use of an error-correction model with both a long- and short-run equation. The regression associated with this primary specification is:

$$\begin{aligned}\varDelta \ln(c_t) = \varphi(\alpha_0 + \alpha_1 r_{t-1} + \gamma_1 NLA_{t-1}/y_t + \gamma_2 IFA_{t-1}/y_t + \gamma_3 HA/y_t +\\ \psi E_t \ln(y_t^p/y_t) + \varsigma DSR_{t-1}^M) + \lambda \Delta \ln(y_t) + \beta_1 \varDelta \ln(c_{t-1}) + \beta_2 \varDelta \ln(u_t) +\\ \beta_3 \varDelta DSR_{t-1}^M + \beta_4 \varDelta DSR_{t-1}^{NM} + \beta_5 (I1990Q4 - I1991Q1) + \varepsilon_t.\end{aligned} \tag{6}$$

Table 12.6: Unit Root Tests, Test Statistic

	(1)	(2)	(3)
	Augmented Dickey Fuller	Dickey Fuller, GLS	KPSS
Consumption	3.665**	–1.260	0.351***
Net liquid assets/income	–1.100	–1.521	0.315***
Illiquid financial assets/income	–2.349	–1.802	0.567***
Housing assets/income	–0.881	–0.748	1.18***
Real interest rate	–5.024***	–1.882	0.199**
Net total wealth to Income	–1.347	–1.460	0.592***
Credit conditions index	–2.152	–1.705	0.148**
Child/adult ratio	–3.772**	–11.026***	0.635**
Consumption/income ratio	–1.507	–2.166	1.03***
Income	–2.538	–1.449	0.353***
Debt-servicing ratio gap	–2.870	–2.399	0.280***
Debt-servicing ratio gap (non-mortgage)	–4.161***	–2.229	0.264***
Expected future income growth	–2.840	–1.520	0.371***

Notes: All tests are analyzed at optimal lag using Akaike criterion; GLS is generalized least squares; KPSS is Kwiatkowski-Phillips-Schmidt-Shin; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculations

Appendix 12C: Full Regression Results – Primary, Sensitivity, Robustness

Table 12.7: Full Regression Results, Primary Specification

	(1)	(2)	(3)
	Consumption Growth		
Forecast future income growth	0.832***	0.737***	0.682***
	(13.47)	(15.07)	(13.89)
Net total HH wealth to income	0.0593***		
	(31.55)		
Net liquid wealth to income		-0.204***	-0.167***
		(-12.36)	(-8.82)
Illiquid financial wealth to income		0.0195***	0.0147***
		(3.76)	(2.9)
Housing wealth to income		0.0231**	0.0089
		(2.46)	(0.91)
L.Real interest rate		-0.00273*	-0.00142
		(-1.89)	(-1.00)
Debt-servicing ratio gap			-0.010***
			(-3.44)
Speed of adjustment	0.0522	0.270***	0.298***
	(1.42)	(4.03)	(4.41)
L.Debt-servicing ratio – mortgage	-0.256	-0.338	-0.479
	(-0.57)	(-0.79)	(-1.08)
L.Debt-servicing ratio – non-mortgage	-0.35	-0.26	-0.235
	(-1.09)	(-0.84)	(-0.74)
Current income growth	0.323***	0.318***	0.334***
	(3.72)	(4.12)	(4.08)
L.Consumption growth	-0.132	-0.165**	-0.172**
	(-1.40)	(-2.13)	(-2.26)
Unemployment rate growth	-0.696**	-0.582**	-0.573**
	(-2.30)	(-2.07)	(-2.02)
Outlier dummies	2.008***	2.497***	2.325***
	(3.87)	(5.66)	(5.02)
Observations	103	103	103
Adjusted R 2	0.362	0.444	0.452
DW	1.794	1.538	1.493

Notes: t-statistic in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Authors' calculations.

Sensitivity Analyses

We tested three other regressions in our sensitivity analysis. Columns 4 and 5 of Table 12.8 add the two different credit conditions indices, while column 6 adds the ratio of children to the adult population.

A brief note on the two credit condition indices. Over time, the target population of loan-to-value regulatory changes to downpayment requirements has differed – for example, in 1992 the regulation was for first-time homebuyers only; in 2006, it was for all homebuyers; and in 2010, it was targeted at refinanced insured mortgages. Given the difficulty of creating a measure that captures each of these different effects, we used the loan-to-value regulation that applied only to first-time homebuyers, who, depending on the year, make up between 35 and 50 percent of the market.

Muellbauer, St-Amant, and Williams (2015, 9) estimate a variable called a latent credit conditions index, which we also tested. As the authors describe, the variable "can be interpreted as the jointly estimated long-run impact of the relaxation of mortgage down payment constraints (and possibly consumer credit constraints) on consumption." In both cases, if the ratio increases, households require a lower down payment, which means increased credit availability and more money accessible for consumption. If the ratio decreases, the opposite occurs and both credit conditions indices act as a credit constraint. Columns 4–6 in Table 12.8 indicate that the coefficient on our variable of interest, the DSR gap, remain similar in both magnitude and direction.

Robustness Checks

To test the reliability of our main results, we performed a set of robustness checks (Table 12.9),[25] including:

25 We note that the robustness check results do not change the findings regarding our main variable of interest, the DSR gap.

Table 12.8: Full Regression Results, Sensitivity Analysis

	(4)	(5)	(6)
	Consumption Growth		
Forecast future income growth	0.675***	0.668***	0.634***
	(13.78)	(13.34)	(13.66)
Net liquid wealth to income	-0.127***	-0.153***	-0.103***
	(-4.03)	(-7.07)	(-3.44)
Illiquid financial wealth to income	0.0132**	0.0116**	0.00817
	(-2.56)	(-2.08)	(-1.66)
Housing wealth to income	0.00971	0.00855	0.0147
	(-1.00)	(-0.87)	(-1.62)
L.Real interest rate	-0.00172	-0.00141	-0.00240*
	(-1.21)	(-0.99)	(-1.81)
Debt-servicing ratio gap	-0.0124***	-0.0118***	-0.0129***
	(-3.79)	(-3.69)	(-4.23)
Credit Conditions Index	0.0516		0.0530*
	(1.59)		(1.76)
Loan to Value		0.0836	
		(1.35)	
Child to Adult population			-0.0194***
			(-4.11)
Speed of adjustment	0.269***	0.298***	0.297***
	(3.83)	(4.44)	(-3.75)
L.Debt-servicing ratio – mortgage	-0.47	-0.501	-0.423
	(-1.02)	(-1.13)	(-0.91)
L.Debt-servicing ratio – non-mortgage	-0.255	-0.229	-0.295
	(-0.81)	(-0.74)	(-0.94)
Current income growth	0.345***	0.338***	0.363***
	(-4.2)	(-4.13)	(-4.36)
L.Consumption growth	-0.166**	-0.166**	-0.171**
	(-2.11)	(-2.16)	(-2.08)
Unemployment rate growth	-0.604**	-0.564*	-0.500*
	(-2.08)	(-1.98)	(-1.72)
Outlier dummies	2.155***	2.380***	2.055***
	(-4.48)	(-5.02)	(-4.2)
Observations	103	103	103
Adjusted R 2	0.431	0.449	0.432
DW	1.531	1.502	1.491

Notes: t-statistic in parentheses,* *p < 0.10*, ** *p < 0.05*, *** *p < 0.01*.
Source: Authors' calculations.

- determining sensitivity to lags – a proxy for endogeneity concerns (column 7);
- replacing net wealth with gross wealth – to isolate the effect of asset value increases on non-housing consumption (column 8); and
- using non-housing consumption, but adding back amounts paid for rent and electricity/gas; if, as risk of ownership increases, people switch to increased renting, consumption in other areas of the economy might not need to change, so by adding rent and electricity/gas, which renters often pay for, we can see if this explains the lack of precautionary savings in the main results (column 9).

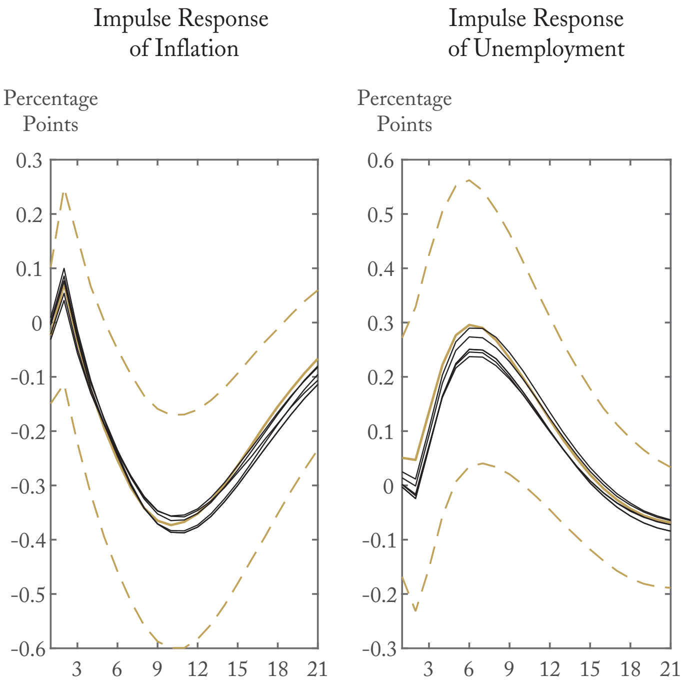
Table 12.9: Full Regression Results, Robustness Checks

	(7)	(8)	(9)
	Consumption Growth		
Forecast Future Income Growth	0.701***	0.640***	0.671***
	(12.61)	(10.42)	(15.79)
Net liquid wealth to income	-0.142***		-0.0965***
	(-6.44)		(-5.87)
Illiquid financial wealth to income	0.00705		0.0104**
	(1.24)		(2.37)
Housing wealth to income	0.0152		0.0200**
	(1.38)		(2.36)
L.Real interest rate	-0.0000748	0.000827	-0.00166
	(-0.05)	(0.43)	(-1.35)
Debt-servicing ratio gap	-0.0130***	-0.0272***	-0.00818***
	(-4.03)	(-9.10)	(-3.32)
Total gross assets to income		0.00961**	
		(2.11)	
Speed of adjustment	0.150*	0.150**	0.287***
	(1.83)	(2.42)	(4.68)
L.Debt-servicing ratio – mortgage	-0.157	-0.538	-0.233
	(-0.28)	(-1.10)	(-0.67)
L.Debt-servicing ratio – non-mortgage	-0.0754	-0.334	-0.145
	(-0.24)	(-1.05)	(-0.59)
Current income growth	0.0473	0.327***	0.258***
	(0.49)	(3.68)	(4.06)
L.Consumption Growth	0.143	-0.165*	-0.179**
	(1.40)	(-1.85)	(-2.31)
Unemployment rate growth	-0.104	-0.707**	-0.357
	(-0.37)	(-2.34)	(-1.63)
Outlier dummies	-1.489***	1.919***	1.954***
	(-4.25)	(3.68)	(5.50)
Adjusted R2	0.056	0.396	0.461

Notes: t-statistic in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Authors' calculations.

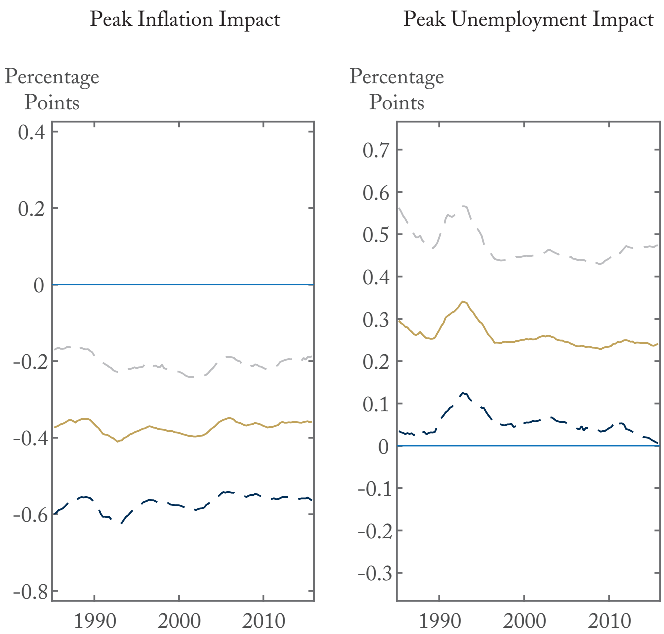
Appendix 12D

Figure 12.5: Impulse Response of Inflation and Unemployment to Monetary Policy Shocks, Canada



Sources: Authors' calculations.

Figure 12.6: Peak impact—Inflation and unemployment, Quarterly, Canada, 1985-2015



Sources: Authors' calculations.

Appendix 12E

We estimate the following equation:

$$effect_{it}^{j} = \alpha_0 + \alpha_1 age_{it} + \alpha_2 mfg_{it} + \alpha_3 credit_{it} + \alpha_4 open_{it} + \eta_{it}\,,$$

where $effect_{it}^{j}$ is the effectiveness of monetary policy for *j* equal to cum_inf (cumulative inflation), cum_unemp (cumulative unemployment), max_inf (maximum inflation) or max_unemp (maximum unemployment), and where the *i*,*t* subscripts indicate the i^{th} province and t^{th} time period, age_{th} is the old age dependency ratio, mfg_{it} is manufacturing intensity, $credit_{it}$ is our proxy for private sector credit and $open_{it}$ is our measure of openness to trade. Finally, η_{it} is a random error term. The α_i and λ are estimated coefficients. The full results of the regression are given in Table 12.10.

Table 12.10: Regression Results

	cum_inf	cum_unemp	max_inf	max_unemp
Age	–0.029 (–1.31)	–0.059 (**) (–2.06)	0.003 (**) (2.00)	–0.006 (***) (–2.64)
Mfg	0.092(***) (5.53)	0.218 (***) (10.10)	0.008 (***) (6.08)	0.0141 (***) (8.17)
Build	–0.039(***) (–13.63)	–0.015(***) (–4.10)	–0.002 (***) (–10.81)	–0.0001 (–0.35)
Open	0.002 (0.52)	–0.008 (*) (–1.94)	0.0004 (1.55)	–0.0001 (–0.38)

Note: * Marginal significance at the 10% level, ** marginal significance at the 5% level, *** marginal significance at the 1% level; analysis is for the period 1992:Q1 to 2015:Q4.

Source: Authors' calculations.

Chapter 13

Concluding Remarks

Our story began with a Bank of Canada at cruising speed. The implementation of the inflation-targeting framework in 1991 brought inflation to within the target range by the mid-1990s. By the beginning of the millennium, the Bank's current institutional framework for the conduct of monetary policy and for communicating its policy was firmly in place. There were only minor tweaks to this institutional framework during the period covered by our book.

The period from 2004 to 2007 coincided with the end of the Great Moderation. We showed that in Canada the reduced variability of inflation and output was partly due to good luck, with subdued aggregate supply shocks over the period, but also that good monetary policy over the period also helps explain Canada's improved macroeconomic performance. We find claims that Canada's monetary policy over this period was too loose unconvincing, and generally give the Bank of Canada high marks for its conduct of monetary policy up to the financial crisis.

Then came the defining event of the period covered by the book: the financial crisis of 2007–08 and the Great Recession. As we saw, the Great Recession was relatively mild in Canada compared both to other postwar Canadian recessions and to its effect in other industrialized countries. We argued that the main cause of Canada's recession was the severe downturn in export demand brought on by the onset of the Great Recession in the United States, where it became the most severe and prolonged economic downturn since the Great Depression of 1929–33.

For its part, the Bank of Canada played an active and important role in resolving the asset-backed commercial paper crisis that accompanied the onset of the financial crisis in Canada. Because the crisis was well contained and quickly resolved, no Canadian financial institution was threatened with bankruptcy. The Bank also reacted promptly to the onset of the recession by reducing its overnight target rate to what was then viewed as its effective lower bound (25 basis points). The Bank's monetary policy and its disciplined, principled provision of liquidity to the financial system contributed to the mildness of the recession.

Slow growth and low inflation have characterized the recovery from the Great Recession in Canada and abroad. In Canada, special circumstances, such as the negative oil price shock in 2014, explain the slow recovery, but its slowness across a wide variety of inflation-targeting countries suggests that the inflation-targeting framework, while not broken, is facing challenges. We reviewed the combination of supply and demand factors that, in our view, explains the anemic nature of the recovery in Canada and other industrialized countries. Although no definitive story explains anemic growth and low inflation, it is certainly the case that we are in a world of lower real interest rates than prevailed before the financial crisis. This means that central banks are facing lower neutral rates of interest, which will make it harder for them to respond to shocks such as the financial crisis, with less room to lower policy rates before they hit their effective lower bounds.

The Bank of Canada faces a number of new challenges in this low-interest-rate world. We have focused on a few that, in our minds, ought to be front and centre, along with possible ways to meet them. Among unconventional monetary policies available in a low-interest-rate environment, and especially when the policy rate hits its effective lower bound, we argued that increases in the money supply can be particularly effective, to the extent that they are considered to be permanent. The Bank's use of a corridor system for implementing monetary policy makes it difficult to envisage a permanent expansion of the monetary base, however, since settlement balances held at the Bank by members of the Canadian Payments Association are allowed to be positive only as a means of providing liquidity to the clearing system. The Bank should think carefully about how to adapt these operating procedures in an environment with a zero or negative overnight rate before it finds itself stuck there.

We argued that some form of price-level targeting would make quantitative easing more effective because it would make the promise of a permanent increase in the monetary base more credible. This, of course, would require a major modification of the monetary policy framework when the Bank of Canada next renews its agreement with the federal government in 2021. In light of this fact, we discussed an elongation of the average inflation-targeting period as a possible solution.

Also as we have shown, after a long period of neglect, renewed efforts by the Bank to look at the informational content and economic significance of monetary aggregates would be worthwhile.

The past responses of central banks to major oil price shocks illustrate how difficult it can be to get the policy mix correct, as well as the high cost of making mistakes. The Great Inflation of the 1970s in the United States and in Canada can be blamed largely on inappropriate accommodation of the two major oil price rises at the beginning and the end of that decade. We also argued that the US Federal Reserve System's response to the oil price increases pre-crisis was similarly inappropriate, and had the effect of worsening the economic downturn that became the Great Recession. For the Bank of Canada, responding to oil prices shocks is much more difficult than just stabilizing aggregate demand. We argued that the Bank should use its formal tools to gain a better understanding of the effect of these oil shocks on capacity output, and use the results of this analysis as a more integral part of its communications strategy to improve the transparency and predictability of its monetary policy more generally.

The Bank of Canada deserves generally good marks for the 2016 renewal of the inflation-control agreement with the federal government. Resisting the temptation to raise the inflation target from 2 percent because of concerns over flexibility at the lower bound of policy rates was wise in light of evidence that even moderate inflation greater than 2 percent could be costly in terms of economic welfare. The important but necessary separation of monetary policy and financial stability also remained well established. Finally, the agreement reflected the results of a deeper investigation into the quality of core CPI measures.

We argued that the Bank of Canada should refine and expand its guidelines for liquidity provision in times of crisis while refraining from taking on direct responsibilities for financial stability that would have significant allocative or distributional consequences. We stressed the merits of having predefined, permanent, market-wide emergency liquidity mechanisms as part of the Bank's day-to-day tool kit. The permanence of such facilities would improve the transparency needed to ensure a well-functioning financial sector, while allowing the Bank to ameliorate its design as financial conditions evolve. Solutions are also available to deal with moral-hazard concerns raised by such facilities. Finally, we made concrete suggestions for the best auction designs for supplying liquidity.

We looked at the evolution of Canadian households' indebtedness, which has been a preoccupation of the Bank of Canada since the financial crisis. We found that households have generally not adjusted their consumption behaviour to the changing composition of their mortgage debt, which has become more principal heavy given persistently low rates since the recession. Our analysis showed that increases in interest rates are unlikely to cause as much consternation as is generally believed. The bigger concern for the Bank might stem from the effect on housing values of a negative economic shock. The lack of precautionary savings by households and their leveraged position from a housing market driven by low interest rates would exacerbate the normal fall in economic activity in such circumstances. The Bank could then have to turn to unconventional monetary policy quicker than it otherwise would.

Lastly, we showed that Canada's aging population acts as a drag on monetary policy effectiveness, which helps to explain the systematic undershooting of inflation since the financial crisis. This finding suggests that the Bank of Canada will have to make more significant changes to the overnight rate target to affect aggregate demand and inflation than it did in the past. This means expansionary monetary policy will be more difficult to conduct, because of the lower neutral rate of interest.

At the time of writing, the recovery from the Great Recession has lasted eight years, making this one of the longest expansions in Canadian economic history. Given Canada's relative success during the crisis, it is unlikely that the Bank of Canada will revise its monetary policy framework in any major way unless there is another significant crisis and recession. Wheels typically are not repaired unless they are broken. This is not, however, a justification for complacency. With lower neutral interest rates and demographics acting as a brake on the effectiveness of monetary policy, the Bank should continue to think about how to make monetary policy effective at the lower bound. It is our hope that the Bank will make these changes before the next financial crisis and/or recession is upon us, and that they will occur in time to blunt the effect of such an event. This might well be the central theme of the next volume in this series.

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