

# Next Steps for Canadian Monetary Policy

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- *While Canada's experience with the two per cent inflation target has been positive, there may still be room for improvement in the Canadian monetary framework. This article reviews our findings to date, places them in the context of the broader literature, and identifies avenues for future research leading up to 2011.*
- *The earlier literature and recent studies at the Bank of Canada suggest that an inflation target lower than two per cent may be beneficial.*
- *With regard to the inflation target, future research should focus on (i) wage-setting behaviour in Canada, especially when inflation is low; (ii) the role that financial intermediaries play in modulating inflation's macroeconomic effects; and (iii) the transition between inflation targets.*
- *It is not yet clear whether a price-level target would be preferable to our current inflation target. Further research into price-level targeting is thus a priority for the Bank's economists.*
- *With regard to price-level targeting, there are several topics for future research, including the target's influence on contracting behaviour and inflation expectations, and how policy-makers can ensure credibility in their commitment to price-level targeting. Furthermore, some empirical assessment is needed concerning the Canadian economy's vulnerability to shocks that the literature identifies as particularly detrimental to the target's performance.*
- *The choice of an inflation target and/or the implementation of a price-level target could have implications for the problem of the zero lower bound on nominal interest rates.*

**A**lthough the Canadian experience with inflation targeting has been very positive, the Bank of Canada remains alert to the potential for improvement in its approach to monetary policy. In 2006, when the inflation-control target was renewed for another five years, the Bank initiated a research program to reassess the current monetary policy framework (Bank of Canada 2006).<sup>1</sup> This reassessment has focused on two questions: (i) What is the optimal rate of inflation? (ii) What are the costs and benefits of a shift to a price-level target?

The Bank's research program aims to answer these questions in collaboration with partners in academia and at other central banks. This article highlights the progress to date and places the Bank's findings in the context of a broader literature. It also identifies avenues for future research and steps that have been taken in these directions. We begin with a discussion of optimal inflation and then move on to price-level targeting (PT). A brief summary of the findings is provided in the conclusion.

## Optimal Inflation

### A brief review of the literature

Although inflation can influence macroeconomic outcomes in many ways, the literature tends to focus on two avenues through which inflation impacts the economy, namely pricing decisions and incentives to hold money. We frame a brief review of the literature around these two channels.<sup>2</sup>

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1 Under this framework, the Bank's monetary policy is aimed at keeping total CPI inflation at two per cent, with a control range of one to three per cent around the target.

2 A third channel, which has been the subject of some Bank of Canada research, is the interaction between inflation and the tax system (see, for example, O'Reilly and Levac 2000; Black, Macklem, and Poloz 1994).

With regard to pricing decisions, the expectation that real prices will erode over time can lead firms operating in inflationary environments to choose prices that differ substantially from those set when inflation is zero. This effect has been studied extensively using New Keynesian models, where monopolistically competitive firms set nominal prices in a staggered fashion using contracts that hold for several periods. In this environment, firms facing trend inflation anticipate that real prices will fall as contracts mature. To compensate, they choose to raise prices by a margin that grows with the expected rate of inflation. This behaviour, sometimes dubbed “front-end loading,” tends to connect higher inflation with greater price dispersion and an inefficient allocation of demand across competitors.<sup>3</sup>

With regard to money-holding incentives, the expectation that the currency’s purchasing power will fall over time can discourage agents from carrying transaction balances, particularly if they could otherwise invest in interest-bearing assets. Economists have recently studied this effect using so-called “search-theoretic” models. In these models, following seminal work by Kiyotaki and Wright (1989), agents choose to hold money because their preferences are unlikely to coincide with those of trading partners. Inflation then influences the amount of money that agents choose to carry, with direct implications for the extent and pattern of trade. An alternative method for modelling the relationship between inflation and money holding is highlighted in Cooley and Hansen (1989), which incorporates money into a real business cycle model via a cash-in-advance constraint.

Estimates on the optimal rate of inflation are quite sensitive to assumptions about which of these channels is stronger. For example, when inflation’s macroeconomic effects accrue only via its impact on pricing decisions, the main goal for policy-makers is normally to minimize price dispersion, and the optimal rate is near zero. On the other hand, if inflation acts only via money-holding incentives, a negative rate can be optimal: As per the famous “Friedman rule” (1969), deflating at a rate that drives the nominal interest rate to zero resolves the money-holding problem by making agents indifferent between transaction balances and interest-bearing investments.

Prescriptions for deflation can hold in search-theoretic settings (see, for example, Lagos and Wright 2005 and Rocheteau and Wright 2005). They also hold in

Cooley and Hansen (1989) and in a subsequent extension to the case of endogenous growth by Gomme (1993), though Gomme finds that the benefits of optimal inflation are relatively small and that the optimal rate is only modestly negative. Several models combining some role for money with New Keynesian price rigidities also find that deflation is optimal, though choosing a target in this setting would now involve balancing the costs associated with price dispersion against those associated with suboptimal money holdings. See Khan, King, and Wolman (2003) for an example. Levin, López-Salido, and Yun (2007) show that strategic complementarities (e.g., quasi-kinked demand and firm-specific capital) tend to enhance the effects of price dispersion, reducing the extent to which money-holding incentives figure in the optimal-inflation decision.

Several related studies aim to estimate the costs of suboptimal inflation from data on money demand. The approach is initially due to Bailey (1956). While varying considerably in their estimates, studies generally find that these costs are modest. Howitt (1990), for example, uses M1 demand estimates produced by Boothe and Poloz (1988) to show that a reduction in Canadian inflation from 9 to 0 per cent would permanently increase output by 0.1 per cent. A key finding in this literature is that results are sensitive to the specification of money demand. For example, Lucas (2000) estimates that lowering inflation from 10 to 0 per cent would improve U.S. output by 0.9 per cent, while an alternative assumption on the money-demand function leads Ireland (2007) to place the gain around 0.1 per cent.

A growing empirical literature has focused on detecting the macroeconomic effects of inflation in time series and international cross-sections. A key theme is that some threshold may exist in the relationship between inflation and economic growth. Despite the findings of Kormendi and Meguire (1985) that the long-run relationship is significantly negative across 47 countries for the years 1950 through 1977, more recent studies, beginning with Fischer (1993), have found that, below a certain rate of inflation, a positive or neutral relationship may exist. Current estimates on this threshold vary dramatically, ranging from 1 per cent for a group of industrial countries in Khan and Senhadji (2000) to 10 per cent for a wider sample in Judson and Orphanides (1996).

## Recent work at the Bank of Canada

The Bank’s most recent contributions to the optimal-inflation literature can be divided between those

3 See Ambler (2007–2008) for a more comprehensive review of inflation’s effects in New Keynesian environments. See also Woodford (2002).

focusing on the New Keynesian environment and those focusing on the search-theoretic perspective.

### ***The New Keynesian approach***

Amano et al. (2007) consider an extension of the New Keynesian framework that incorporates exogenous productivity growth and staggered wage and price setting. In addition to the standard “front-end loading” effect, the authors also document an effect that stems from the interaction of inflation, productivity growth, and nominal wage rigidity: Deflation partially compensates for nominal wage rigidity by allowing the real wage to rise as labour productivity improves. Realistic parameterizations imply that the wage effect has stronger welfare implications than price dispersion, leading the authors to conclude that deflation near the rate of productivity growth is optimal. This is consistent with some insights from an earlier literature on the potential benefits of negative trend inflation when productivity improves over time (Selgin 1995).

As explained above, the case for deflation normally depends on some assumption that agents face incentives to hold transaction balances. No such incentives exist in Amano et al. (2007), which features neither a cash-in-advance constraint nor a preference for money holdings and yet finds that deflation is optimal.<sup>4</sup> Amano et al. (2007) also find that deviations from the optimal rate can be quite costly, mainly because of nominal wage rigidities. A shift from two per cent inflation to the optimum improves welfare by 0.8 per cent. This estimate is high relative to those found in previous literature, even in studies featuring staggered price setting.

While Amano et al. (2007) focus on inflation’s steady-state effects, Amano, Ambler, and Rebei (2007) consider a more dynamic setting. They relax one of the literature’s most common assumptions—that firms failing to reset their prices nonetheless index them to trend inflation—and then estimate the effects of trend inflation in a stochastic environment where firms face various nominal price rigidities.<sup>5</sup> The study extends related work by Bakhshi et al. (2003) and Ascari (2004).

An important finding in Amano, Ambler, and Rebei (2007) is that trend inflation tends to impact the stochastic means of output, consumption, price dispersion, and other key variables more dramatically than

their steady states. These results follow naturally from the fact that inflation is more persistent at higher rates of trend inflation. Increases in the volatility and persistence of several macroeconomic variables also follow directly from this relationship, which is invariant to the exact form of nominal rigidity in effect. The authors conclude that estimates based on steady-state calculations are likely to understate the welfare effects of trend inflation. Because the connection between trend inflation and price dispersion is key to their results, they find that inflation near zero is optimal.

### ***The search-theoretic approach***

Compared with the New Keynesian approach, which either focuses on cashless economies or introduces money via ad hoc assumptions, monetary search theory explicitly models the frictions that give rise to the need for money. In a key study by Lagos and Wright (2005), for example, agents choose to hold money because, as explained earlier, their preferences are unlikely to coincide when meeting potential trading partners.<sup>6</sup>

At the Bank, Chiu and Molico (2007, 2008) extend the Lagos and Wright (2005) framework to study inflation’s effects when money holdings vary across households. Their model is constructed to be consistent with data on aggregate money demand, as well as the distribution of money holdings across households. In this model, inflation can have significant redistributive effects that transfer real balances from cash-rich households to cash-poor households. These redistributive effects partially offset inflation’s negative impact as a tax on money holding. As a result, some positive deviation from the Friedman rule can be welfare improving. Furthermore, the costs of suboptimal inflation are found to be smaller than in previous estimates and exhibit non-linearities that invalidate the methodologies applied in Lucas (2000) and Ireland (2007), where costs are calculated from the area under the money demand curve. In contrast to Lucas’s estimate of 0.9 per cent, Chiu and Molico (2008) find that reducing inflation from 10 to 0 per cent improves welfare by only 0.59 per cent.

### **Challenges for the future**

The range of estimates on the optimal rate of inflation suggests that findings in the literature are sensitive to assumptions about the economy and the avenues by which inflation can affect real outcomes. Future

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4 Wolman (2009) makes a similar case for deflation in a two-sector economy where the relative price of output produced by the sector with greater nominal rigidities is increasing over time.

5 The assumptions that firms index to target inflation or to some weighted average of past inflation are also common and were relaxed in Amano, Ambler, and Rebei (2007).

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6 Although agents could conceivably use credit arrangements as an alternative to money holding, an assumption that agents transact anonymously implies that credit contracts cannot be enforced.

research must therefore test how robustly these findings hold as assumptions are relaxed and replaced. Below, we consider four interesting extensions.

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### **The implications of financial intermediation**

A key finding in Chiu and Molico (2007) is that inflation can have non-linear welfare effects, depending on how inflation affects agents' decisions to adjust their money holdings. The ease with which these adjustments can be made likely varies with the structure and sophistication of the banking sector. In this sense, financial intermediaries can play a role in the optimal-inflation narrative.

Another avenue through which intermediaries might modulate the effects of inflation is explored by Chiu and Meh (2008), who recently extended earlier work by Berentsen, Camera, and Waller (2007). Chiu and Meh suppose that entrepreneurs are randomly apprised of investment opportunities and have access to financial intermediation. If a project's costs exceed or fall short of an entrepreneur's money holdings, the entrepreneur can borrow or lend the difference, respectively, although potentially at some fixed cost. In this way, Chiu and Meh capture the role that intermediaries play as providers of liquidity, although they abstract from other roles, such as credit monitoring.

In this environment, interesting non-linearities emerge in the relationships among welfare, intermediation, and inflation. At high levels of inflation, banks are able to improve welfare by offering entrepreneurs a return on their money holdings, motivating them to hold more transactions balances and, thus, to invest in marginal projects. At the Friedman rule, firms cannot justify the fixed cost of intermediation, and liquidity provision by intermediaries cannot improve welfare. At intermediate rates of inflation, it is possible for liquidity provision to have negative welfare effects, since agents fail to take into account a potential externality when borrowing, namely, that an agent's option to borrow reduces his/her demand for money, which can cause the liquidity constraints of other agents

to tighten if these agents hold money.<sup>7</sup> As a result, accurate estimates of the welfare effects of a change in the inflation target need to take into account potential shifts in the extent and pattern of liquidity provision by intermediaries. Further inquiry into the role of intermediaries in modulating inflation's welfare effects, particularly during periods of financial instability, would be worthwhile.

### **Transition between targets**

In estimating the welfare effects associated with a shift towards the optimal rate of trend inflation, several of the Bank's recent projects, including Amano et al. (2007) and Chiu and Molico (2007, 2008), compare the long-run implications of trend inflation, ignoring the economy's short-run behaviour during the transition. However, this behaviour may be important: If the differences that emerge in the long-run analysis are modest, then after discounting, they could be offset by losses during transition. Some attention to short-run dynamics is therefore warranted.

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*The credibility of central bankers can be an important contributor to successful transitions between targets.*

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Inflation expectations and how agents update them figure prominently in the modern literature on inflation targets. Andolfatto and Gomme (2003), Erceg and Levin (2003), and Moran (2005) all model transitions where agents gradually learn about changes in the central bank's inflation target, rather than assimilating these changes immediately. Moran (2005) demonstrates that the welfare costs during transition vary dramatically with the speed of the learning process, suggesting that the credibility of central bankers can be an important contributor to successful transitions.

### **New emphasis on labour markets**

The finding in Amano et al. (2007) that nominal wage rigidities account for most of inflation's welfare costs suggests that labour markets can play an important role in determining the optimal rate of inflation. Further study into this role should prove worthwhile. In ongoing work, Amano, Murchison, and Shukayev

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<sup>7</sup> However, as mentioned earlier, this model considers only the brokering, or "liquidity-provision" function of financial intermediaries. A full assessment of intermediation's welfare effects should also consider credit monitoring and other functions.

(2009) relax the allocative wage assumption implicit in Amano et al. (2007): Rather than assuming that workers commit to service whatever demand their nominal wage elicits, as is common in the New Keynesian literature, the authors suppose that workers simultaneously contract on nominal wages and hours worked. The impact of inflation on the labour market is thus substantially weakened. Hours worked remain fixed for most contracts despite inflation-induced shifts in the real wage, and any contracts being renegotiated take these shifts fully into account when setting *both* hours *and* the nominal wage. As a result, it is preferable for the central bank to set policy to minimize distortions elsewhere in the economy. With nominal rigidity in product markets, for example, the optimal rate of inflation is close to zero, rather than being negative, as suggested in Amano et al. (2007). As well, deviations from the optimum prove much less costly than in Amano et al. (2007).

One avenue for future research relevant to the role of labour markets in determining optimal inflation focuses on downward rigidity in nominal wages. Several authors have argued that firms find it difficult to reduce nominal wages and thus have greater freedom to lower real wages when inflation is positive (see, for example, Akerlof, Dickens, and Perry 2000). Statistical evidence of some downward rigidity in Canadian wages is documented in Crawford and Harrison (1998), although Farès and Hogan (2000) fail to find signs that low inflation has hindered the operation of Canadian labour markets. Kim and Ruge-Murcia (2007) recently embedded downward rigidity into a dynamic stochastic environment and placed optimal inflation around 1.2 per cent in the United States.

### ***The zero lower bound on nominal interest rates***

As explained in Summers (1991), it may be difficult to implement expansionary monetary policy when rates are at or near zero, since nominal interest rates cannot be negative. Various authors have since noted the example of recent economic weakness in Japan during the years 1995–2005, when short-term rates largely held in this range.

The relevance of the zero lower bound in choosing an inflation target is open to debate. Schmitt-Grohé and Uribe (2007), in their extension of the framework of Altig et al. (2005), show that the bound has no significant implications for their finding that mild deflation is optimal. If the lower bound argument holds, however, it offers an obvious counterbalance to the Friedman

rule, which explicitly advocates an inflation target that forces nominal interest rates to zero. It would be optimal for policy-makers instead to target a more positive rate and thus reduce the likelihood of striking the bound. At the Bank, Lavoie and Pioro (2007) show that this likelihood falls as the target rises, so that a two per cent target provides a buffer over the zero bound. In more recent work, Nishiyama (2009) shows that a positive target's usefulness as a buffer grows with the lags attending monetary transmission. Outside the Bank, using a stochastic model where central bankers explicitly trade off the costs of inflation and the likelihood of reaching the bound, Billi (2007) places the optimal inflation rate around 0.7 per cent, which rises to 1.4 per cent when a specific type of model uncertainty is taken into account.

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*The significance of the zero lower bound has increased in the aftermath of the 2007 subprime-mortgage meltdown.*

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The significance of the zero lower bound has increased in the aftermath of the 2007 subprime-mortgage meltdown, which prompted dramatic reductions in the policy rates of central banks throughout the developed world. At the Bank of Canada, for example, these developments have motivated recent efforts to better incorporate the zero bound into our projection framework. Further research focusing specifically on the connections between the inflation target and the zero lower bound, as in Lavoie and Pioro (2007) and Nishiyama (2009), should be a priority in the future.

## **Price-Level Targeting**

### **A brief review of the literature**

Despite its recent successes in terms of macro-stabilization, several authors have highlighted some shortcomings in the inflation-targeting (IT) framework. Most notably, uncertainty on the price level grows with the planning horizon, since central banks with inflation targets accommodate shocks to the price level, taking the post-shock level as given and aiming to stabilize inflation from this level. In fact, the price level is unbounded at very distant horizons. Price-level targeting (PT) mitigates this uncertainty by committing central banks to restore the price level to a pre-announced target following shocks. PT is frequently

described as a departure from IT's prescription for letting "bygones be bygones."

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*A common argument in favour of price-level targeting highlights its effects on inflation expectations.*

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A common argument in favour of PT highlights its effects on inflation expectations, which may motivate stabilizing behaviour among agents. Thus, under PT, the expectation that policy-makers will target below-average inflation, following positive shocks to the price level, discourages firms from raising prices as dramatically as they would under a regime that accommodated shocks (Svensson 1999). Thus, acting via this expectations channel, PT could theoretically deliver lower volatility in both output and inflation. This finding represents a dramatic departure from the earlier view that PT necessarily involved greater volatility in inflation, since periods of below-average inflation would follow periods of above-average inflation (and vice versa).

While Svensson's analysis focuses on the New Classical Phillips curve, Dittmar and Gavin (2000) and Vestin (2006) show that his findings also hold in a New Keynesian setting. Steinsson (2003) identifies an important exception to the dominance of PT over IT, namely, when a large number of so-called "rule-of-thumb" firms set their prices according to a backward-looking rule. In fact, failure can occur owing to any factor that induces sufficiently backward-looking inflation expectations.

Another argument in favour of PT emphasizes the costs imposed on risk-averse agents facing price-level uncertainty whenever they enter into contracts whose terms are imperfectly indexed to inflation, such as mortgages. To the extent that PT reduces these costs, it may create an incentive for long-term financial contracting, with potential benefits for output and welfare. Views as to whether significant benefits should be expected vary considerably, as shown recently in Ambler (2007–2008) and Côté (2007). Howitt (2001) describes "long-term price-level uncertainty [as] one of the most serious consequences of inflation, because of its ruinous effects on long-term contracting," while Fischer (1994) argues that agents already have sufficient access to insurance against this uncertainty, mainly through indexed bonds.

## Recent work at the Bank of Canada

In recent years, PT has attracted greater attention among the Bank's researchers than has optimal inflation. This work can be divided into four areas: (i) PT's general merits from a macrostabilization perspective; (ii) central bank credibility and its implications for PT; (iii) the challenges for PT in a small, open economy; and (iv) avenues through which PT can affect an agent's decision to enter into long-term contracts. We consider each area in turn.

### *Price-level targeting as a stabilizing tool*

As noted in the literature review, the role of expectations as automatic stabilizers opens up the possibility that PT may dominate IT in certain environments. This possibility prompts Cateau (2008) to test PT's performance in Canada using our main projection model, ToTEM.<sup>8</sup> His key finding is that PT indeed outperforms IT. He also finds that, relative to IT, PT proves more robust to model uncertainty in the sense of Hansen and Sargent (2008); that is, if ToTEM is assumed to represent an inaccurate version of the Canadian economy, then PT's performance suffers less dramatically as the model's inaccuracy increases.

Further evidence that PT outperforms IT is offered in Coletti, Lalonde, and Muir (2008), based on work with a Canada–U.S. version of GEM, the IMF's Global Economy Model, calibrated to fit U.S. and Canadian data. The finding that PT performs better than IT is robust to several assumptions, including the specification of U.S. monetary policy. Gains, however, are modest relative to IT. PT tends to trade less-volatile inflation for more-volatile output, rather than reducing volatility in both variables.

Coletti, Lalonde, and Muir (2008) find that PT outperforms IT specifically following shocks that generate positive correlation between inflation and the output gap (such as demand shocks), whereas IT performs better following shocks that induce negative correlation between these variables (such as markup and labour supply shocks). The case for PT thus proves sensitive to the structure and distribution of shocks. In Coletti, Lalonde, and Muir (2008), the finding that PT generally performs better than IT follows from the fact that shocks generating positive correlation between inflation and the output gap account for a greater share of volatility in these variables when the model is taken to Canadian and U.S. data.

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<sup>8</sup> See Murchison and Rennison (2006) for an overview of ToTEM.

Another key finding in Coletti, Lalonde, and Muir (2008) is that the benefits associated with the shift to PT rise with the weight assigned to forward-looking expectations in the Phillips curve. This point is consistent with the notion that PT operates better when expectations are strongly forward-looking.

While Cateau (2008) and Coletti, Lalonde, and Muir (2008) consider PT in the context of large-scale models, Covas and Zhang (2008) use a more stylized framework based on Bernanke, Gertler, and Gilchrist (1999) to test how robustly the case for PT holds in the presence of financial frictions. More specifically, they consider a sticky-price environment in which entrepreneurs have access only to nominal debt contracts, while capital producers face counter-cyclical, quadratic costs when issuing equity. In this environment, PT continues to dominate IT, although the gain is smaller when financial frictions are taken into account. As in Coletti, Lalonde, and Muir (2008), the results depend on the kind of shocks being modelled. PT's weaker performance in the presence of financial frictions stems directly from a shock to the capital-producing technology; when frictions exist, this shock tends to generate a negative correlation between inflation and the output gap, forcing an undesirable trade-off onto PT.

### ***Credible commitment to price-level targeting***

The potential for expectations to serve as automatic stabilizers under PT suggests that performance will depend on the extent to which policy-makers can influence inflation expectations. As a result, the credibility with which policy-makers implement PT likely influences the target's performance, a possibility explored in Kryvtsov, Shukayev, and Ueberfeldt (2008), Cateau et al. (2009), and Masson and Shukayev (2008).

Kryvtsov, Shukayev, and Ueberfeldt (2008) consider the costs of imperfect credibility during the transition from IT to PT. Specifically, they suppose that agents are initially uncertain that the central bank will follow through on its commitment to PT and believe that policy-makers may revert to IT. A key finding is that PT's performance suffers when uncertainty is persistent. Expectations fail to serve as strong stabilizers to the extent that agents forming these expectations assign a positive weight to the shift back to IT. In this case, greater output losses are required to achieve a given price path, relative to the case where policy-makers are perfectly credible. In fact, when persistence exceeds a threshold—specifically, when

uncertainty lasts for 10 quarters or more—the authors find that costs arising from imperfect credibility more than offset the benefits accruing from PT's superior performance once credibility has been established. See Cateau et al. (2009) for an extension that uses ToTEM to study PT's performance when agents are initially unconvinced of the central bank's credibility. As in Kryvtsov, Shukayev, and Ueberfeldt (2008), the authors find that imperfect credibility reduces the benefits associated with the shift from IT to PT.

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*PT's performance suffers when uncertainty about a central bank's commitment to PT is persistent.*

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In contrast to these two studies, Masson and Shukayev (2008) consider a chronic challenge attending credible commitment to PT. Even after the central bank has shifted from IT to PT, the authors expect that agents may question the bank's willingness to adhere to PT in the face of large shocks that can be reversed only at substantial cost to output. Thus, agents attach some probability to policy-makers' opting to reset the price path.

Masson and Shukayev argue that a precedent for such behaviour can be found in the history of the gold standard in the early 20th century, when the standard was suspended and resumed at new parities. This precedent suggests that PT would likely be implemented with an "escape clause," explicit or otherwise. Masson and Shukayev (2008) develop a model for the escape clause by supposing that a drop in the output gap below some threshold triggers a reset in the price target. In this case, much like Kryvtsov, Shukayev, and Ueberfeldt (2008), agents' assignment of some probability to a reset when forming inflation expectations means that these expectations fail to serve as strong stabilizers. This failure necessitates more aggressive policy, which in turn leads to higher output volatility. This last effect is quite pronounced. For example, when the threshold is set at a level implying that resets will occur with unconditional probability of 0.4 per cent, the output gap is about 30 per cent more volatile than in an economy without an escape clause.

Because the conditional probability of reset evolves endogenously, higher volatility in turn increases the likelihood that the threshold will be breached, potentially giving rise to self-fulfilling crises and multiple equilibria. The authors identify a range of thresholds,

for example, for which their model can support both good and bad equilibria, where bad outcomes are associated with greater volatility and higher probability of reset. These findings suggest that PT's performance hinges critically on the credibility of monetary policy.

### ***Price-level targeting in an open economy***

Large, persistent shocks to the terms of trade have been identified as a potential threat to PT in small open economies. The concern here is that central bankers could induce large output fluctuations if they are to unwind all pass-through to the price level.

In their work with a Canada–U.S. version of GEM, Coletti, Lalonde, and Muir (2008) find that PT continues to dominate IT even in the face of shocks accounting for most of the variation in Canada's terms of trade. However, in ongoing work at the Bank, De Resende, Dib, and Kichian (2008) and Amano, Kryvtsov, and Murray (2009) develop open-economy models in which PT's performance can be compromised.

While Coletti, Lalonde, and Muir (2008) abstract from commodity markets and their potential implications for PT's performance in small, open economies, ongoing work by Coletti et al. (2009) considers the transmission of global commodity market shocks using a Canada–U.S. version of GEM that explicitly includes oil and commodity sectors.<sup>9</sup> The authors find that permanent oil supply shocks generate greater macroeconomic volatility under PT, relative to IT. PT's poor performance following these shocks is due to the fact that oil suppliers and demanders face substantial real adjustment costs; as a result, shocks induce highly persistent cost-push pressures, leading to a significant deterioration in the inflation-output trade-off available to central banks, particularly price-level targeters.

### ***Price-level targeting and long-term contracting***

The notion that PT may influence long-term financial contracting through a reduction in price-level uncertainty is central to recent work by Meh, Ríos-Rull, and Terajima (2008). The authors develop a framework for estimating the effects of price-level uncertainty on the value of imperfectly indexed assets and liabilities. Using a data-intensive procedure from Doepke and Schneider (2006), they estimate the changes in the

distribution of wealth that occur as real payouts vary in response to unexpected shifts in the price level. They then use a heterogeneous-agent framework to understand how redistribution might impact savings and labour decisions for household groups varying in terms of age and socio-economic status.

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*Long-term instruments are less likely to occasion redistribution under PT.*

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Since redistribution occurs only if the price level differs at payout from the investor's initial expectation, long-term instruments are less likely to occasion redistribution under PT, which commits the central bank to restore the price path within a certain horizon. Since Meh, Ríos-Rull, and Terajima (2008) find that the average Canadian household holds about 70 per cent of its unindexed assets and liabilities in the form of long-term instruments, PT is able to mitigate the potential for redistribution considerably. Indeed, for a given price shock, the authors report that the extent of redistribution is smaller under PT, relative to IT; effects on labour, savings, and other key macroeconomic variables also tend to be smaller under PT. Since the danger that price shocks will trigger some real redistribution of wealth between borrowers and lenders is a disincentive to long-term nominal contracts, the results suggest that these contracts might be more popular under PT.

The notion that PT is better able to stabilize the real distribution of wealth is also highlighted in Dib, Mendicino, and Zhang (2008), which models business cycles in a multi-sector open economy featuring nominal price rigidities and nominal debt contracts. PT's dominance in this environment stems from the fact that policy-makers are able to rely on automatic stabilizers in achieving their goals, reducing the extent to which they must vary the real interest rate. As a result, there is less potential for redistribution between borrowers and lenders in the market for nominal debt. On the other hand, the real interest rate varies more dramatically under IT. IT is thus forced to trade volatility in the rate of inflation for volatility in the real interest rate, leaving policy-makers ill-equipped to manage *both* price dispersion in the goods market *and* distortion in the nominal debt market. The result proves robust to parameter uncertainty, although the benefits associated with a shift to PT are diminished if IT is implemented with some weight on interest-rate smoothing.

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<sup>9</sup> See Lalonde and Muir (2007) for a full description of this model.



## Challenges for the future

From the foregoing discussion, we can identify several topics for future research. Furthermore, financial intermediaries and labour markets, aside from their implications for optimal inflation, are likely also relevant in the IT-PT debate. In what follows, we focus on four avenues for future research.

### **Empirical assessment**

Although many of our findings to date tend to favour PT over IT, we have shown that PT's performance is sensitive to several factors, including the structure and distribution of shocks and the process underlying the formation of inflation expectations. In particular, PT tends to perform poorly when inflation expectations are highly backward-looking and/or when the economy is vulnerable to large markup shocks, labour supply shocks, and other shocks generating negative correlation between output and inflation. Shocks to the terms of trade and certain commodity shocks may also present challenges. Some empirical assessment is needed to determine whether these problems are quantitatively relevant in the Canadian case.

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*PT's performance is sensitive to the structure and distribution of shocks and the process underlying the formation of inflation expectations.*

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With regard to inflation expectations, an accurate assessment could be quite challenging, since the literature is currently divided on the extent to which backward-looking behaviour influences these expectations. Galí, Gertler, and López-Salido (2005), for example, find that the influence is minimal, while Rudd and Whelan (2005) argue that the influence is important, a point with which Dorich (2009) concurs in ongoing work at the Bank. See Dorich (2009) for a thorough review of the literature and a novel approach to the problem.

### **Endogenous contracting**

In studies that apply sticky-price models to the IT-PT debate (e.g., Covas and Zhang 2008), the results can be sensitive to assumptions regarding nominal rigidities. In Covas and Zhang (2008), for example, some assumption must be made about the likelihood that a firm will adjust its nominal price in the

current period.<sup>10</sup> Unfortunately, this likelihood may vary across IT and PT regimes, particularly if PT encourages a shift into long-term nominal contracts, as suggested earlier, since PT might then lead firms to adjust prices less frequently. This is an example of the famous “Lucas critique” (1976), which notes that models for policy can be misleading if they fail to take into account all avenues via which policy can affect economic behaviour.

If the Lucas critique is applicable, then future research will require frameworks in which nominal rigidities are at least partially endogenous to monetary policy. Amano, Ambler, and Ireland (2007) have developed a framework that allows households to choose the extent to which their wage contracts are indexed to deviations from trend inflation, conditional on the monetary policy that is in effect. The authors find that households prefer less indexation under PT, mainly because they expect that positive deviations will be unwound as policy-makers aim to restore the target path for the price level.

These points can also apply to financial contracts. In this regard, it is important to note that Meh, Ríos-Rull, and Terajima (2008) take as *given* the portfolios of households, businesses, government, and foreigners when estimating the redistributive effects of inflation under IT and PT. In fact, under a PT regime, agents might opt to hold portfolios with different maturities and/or indexation status. This suggests the need for frameworks that endogenize portfolio choice with respect to monetary policy. Meh, Quadriini, and Terajima (2009) have recently developed a micro-founded model for contracting on indexation status. In ongoing work highlighted in this issue, they have also sought to endogenize choice across maturities.

### **Endogenous credibility**

Aforementioned work by Kryvtsov, Shukayev, and Ueberfeldt (2008), Cateau et al. (2009), and Masson and Shukayev (2008) suggests that imperfect credibility among central bankers can undermine PT's performance. It is natural then to ask what steps policy-makers can take to better ensure their credibility. Research on this front, with special attention to the Bank's communication strategy, would be interesting and rewarding.

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<sup>10</sup> Covas and Zhang (2008) consider staggered price setting in the sense of Calvo (1983). If we instead considered staggered price setting in the sense of Taylor (1980), as in Amano et al. (2007), the relevant assumption would have to do with the number of periods over which nominal price contracts remain in effect.

## **The zero lower bound on nominal interest rates (II)**

Several authors have recently argued that PT offers a (partial) solution to the problem of the zero lower bound. Svensson (2003) argues that commitment to an upward-sloping price path can help policy-makers to escape a situation where the constraint binds, while Eggertsson and Woodford (2003) and Wolman (2005) suggest that nominal interest rates are less likely to reach their lower bound under PT.

The Bank's researchers and policy-makers are very interested in the zero lower bound, including its implications for PT's performance. Lavoie and Pioro (2007), for example, have used ToTEM to study some of these implications in a Canadian context. In the future, this aspect of the argument in favour of PT will continue to receive attention at the Bank.

## **Conclusions**

The key findings of this review can be summarized briefly. An inflation target below two per cent is likely preferable to the status quo. At this stage, however, it is unclear how much Canadians would benefit from some shift to a lower target. It is also unclear how much lower policy-makers should aim. With regard to a lower inflation target, future research topics include the influence of labour markets and financial

intermediaries and the economy's behaviour during transition between targets.

It is also unclear whether a price-level target could improve upon our current inflation target. In particular, the performance of a price-level target may suffer if inflation expectations are highly backward-looking and/or if the economy is vulnerable to shocks generating negative correlation between output and inflation, such as markup shocks, labour supply shocks, and certain commodity shocks. Future research should assess whether these factors are quantitatively relevant for Canadian monetary policy. Other topics for future research include PT's influence on contracting behaviour and strategies for improving central bank credibility under PT.

The choice of an inflation target and/or the implementation of a price-level target could have implications for the problem of the zero lower bound. This possibility needs to be explored more thoroughly, particularly in the current financial climate.

More generally, in this review we aimed at conveying a sense of our findings and the avenues by which they will inform the 2011 decision regarding the Bank's monetary policy framework, while highlighting questions that must be addressed in the time that remains.

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