Inflation Targeting, Price-Level Targeting, and Fluctuations in Canada's Terms of Trade

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- *Despite numerous successes, inflation targeting (IT) has some notable shortcomings. In particular, it does not define the future path of the price level, which may result in costly uncertainty for the economy.*
- *Price-level targeting (PLT) reduces future price-level uncertainty, but it is not clear whether this comes at the expense of increased macroeconomic instability, including that caused by large and persistent shocks to Canada's terms of trade.*
- *Research suggests that, compared with IT, PLT delivers a reduction in consumer price inflation and nominal interest rate variability at the expense of slightly higher output-gap variability.*
- *These results are highly sensitive to the interaction between the relative incidence of different macroeconomic shocks and the extent to which price setting is forward looking.*

In November 2006, the Government and the Bank of Canada announced the renewal of Canada's inflation-control agreement (Bank of Canada 2006). Under the terms of this five-year agreement, the Bank of Canada is committed to maintaining the year-over-year change in the consumer price index at the 2 per cent midpoint of a 1 to 3 per cent target range. This is the fourth consecutive inflation-control agreement since the announcement of the inflation-reduction targets in 1991. At that time, Canada followed New Zealand to become the second country in the world to introduce inflation targets; since then, more than 21 countries have followed suit. The Canadian and international experience with inflation targeting (IT) suggests that the policy has been a major success. Perhaps the most significant testament to this is that, despite numerous challenging macroeconomic developments, no country has abandoned the arrangement (Svensson 2008).

Despite significant achievements—lower average inflation rates, less inflation variability, more firmly anchored inflation expectations, and less variability in output relative to capacity—IT has notable shortcomings. In particular, IT does not require a credible commitment to long-run stability in the price level. In practical terms, shocks to the price level under IT are simply accommodated and thus not reversed. As shown in Chart 1, when an economy is facing random shocks, uncertainty about the future price level rises without limit as the planning horizon increases, even though uncertainty around the inflation rate is capped at its unconditional variance. Price-level uncertainty is particularly problematic for risk-averse economic agents who enter into imperfectly indexed, long-term

Chart 1

Stylized Confidence Intervals under Inflation Targeting

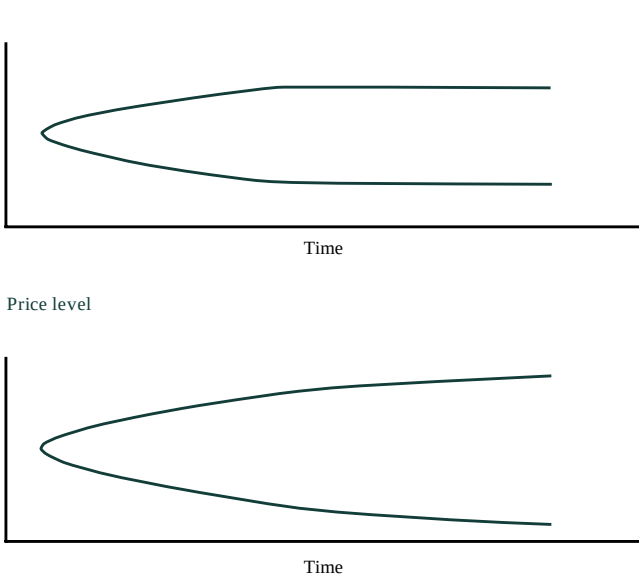
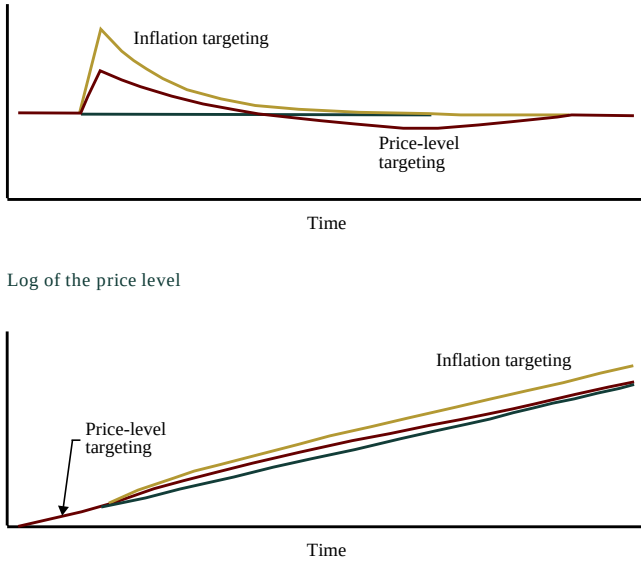


Chart 2

Inflation Targeting vs. Price-Level Targeting



nominal contracts (e.g., mortgages).[1] Although the quantitative significance of price-level uncertainty remains an open question, it is considered, conceptually at least, a weakness of inflation targeting.[2]

An alternative monetary policy strategy that directly addresses the issue of price-level uncertainty is price-level targeting (PLT). PLT differs from IT in that the central bank makes an explicit commitment to meet a publicly announced numerical target for the price level rather than an inflation target. Intuitively, the difference between IT and PLT is that, under inflation targets, shocks to the price level are accommodated, while under price-level targets shocks to the price level are reversed. The difference between the behaviour of PLT and IT for a positive shock to prices is shown in Chart 2. By focusing on the price-level target, central banks can reduce the uncertainty associated with the future level of prices.

The price-level target could be specified as a constant or it could be allowed to grow at some predetermined rate, e.g., 2 per cent, as in Chart 2. It has been argued that allowing the price-level target to grow reduces both the likelihood of hitting the zero lower bound on nominal interest rates (see Lavoie and Murchison, this issue) and of encountering the potentially destabilizing effects of deflation when compared with a constant target.

Critics of PLT have traditionally argued that it would lead to increased macroeconomic variability in both inflation and output.

In recent years, several important papers have compared the relative merits of IT and PLT; summaries of the literature can be found in Ambler (2007) and Côté (2007). Briefly, critics of PLT have traditionally argued that it would lead to increased macroeconomic variability in both inflation and output, since returning the price level to its target necessitates greater variability in the inflation rate than does simply returning inflation to target. Greater inflation variability combined with the presence of nominal rigidities in the economy implies that there must also be greater variability in the real side of the economy. Others have responded that, under certain conditions, PLT could in fact deliver more macro stabilization than does IT (Woodford 1999). This view relies heavily on the assumption that expectations of future inflation are forward looking and take into account, among other factors, the state-

1. It is important to note as well that the impact of price-level uncertainty is regressive. Low-income individuals cannot easily hedge this uncertainty.

2. In an alternative strand of the literature it is argued that, in the face of productivity shocks, an unvarying and hence "certain" price level is detrimental to economic agents who enter into nominal contracts (Selgin 1997).

ments and actions of a highly credible central bank. Under PLT, inflation expectations act as a powerful stabilizer, limiting the response of price- and wage-setters to shocks that have consequences for inflation.

This article provides a relatively non-technical summary of a recent Bank of Canada paper that compares the relative ability of PLT and IT to stabilize the macro economy when confronted by shocks similar to those seen in recent history.[3] The first part of the article explains the methodology, while the second section focuses on overall results, followed by a discussion of a number of sensitivity analyses. The third section pays special attention to the role played in the analysis by shocks to Canada's terms of trade. Our interest in terms-of-trade shocks comes about because, under PLT, persistent movements in the terms of trade could require significant declines in other relative prices in order to bring the average price level to target. In the presence of nominal rigidities, this could induce increased output variability. This argument is accentuated by the difference in price rigidities, which are greater in the non-traded goods sector of the economy than in the traded goods sector. The article concludes by highlighting future research.

Methodology

Coletti, Lalonde, and Muir (henceforth CLM 2008a, b) study the relative ability of PLT and IT to stabilize the macroeconomy in a state-of-the-art, multi-country, dynamic general-equilibrium model. CLM use a stripped-down version of the International Monetary Fund's Global Economy Model (GEM) (Pesenti 2008). The version of GEM used by CLM features two countries—Canada and the United States—and two sectors, tradable and non-tradable goods. Non-tradable goods are assumed to cover all services except financial services. All other goods are assumed to be tradable goods.

A key assumption of the study is that several differentiated tradable (and non-tradable) goods are being produced in each country.[4] Product differentiation gives firms some market power, which allows them to set a price that is above their marginal cost of production. Product differentiation also allows for the possibility that the basket of goods produced in Canada for export to the United States will be different from those produced by U.S. firms for export to Canada, leading to a meaningful distinction between the terms of trade and the real exchange rate.[5] Other important features of the model include nominal rigidities in the form of both wage and price rigidity. The model also allows for a form of indexing of inflation to past inflation, which can be thought of as reflecting the existence of rule-of-thumb price-setters who base their expectations of future inflation on last period's inflation outcomes. Real rigidities, including habit-formation in consumption and leisure and adjustment costs in investment, help to generate the observed persistence in movements in the real economy.

The study compares the ability of simple IT and PLT rules to stabilize the macroeconomy under the assumption that the two-country model would be hit by shocks similar in size to those seen in Canada and the United States over the 1983–2004 period.[6] The authors assume that the central bank cares principally about stabilizing the variability of output relative to production capacity and the variability of consumer price inflation.[7] More formally, the central bank seeks to minimize the following quadratic loss function:

$$\bar{L} = \sigma^2_{\pi} + \sigma^2_{ygap} + 0.1 \cdot \sigma^2_{\Delta R}, \qquad (1)$$

where σ^2_{π}, σ^2_{ygap}, and $\sigma^2_{\Delta R}$ are the unconditional variances of the gap between consumer price inflation (π) and the target inflation rate (π^T), the output gap (*ygap*), and the change in the policy interest rate (ΔR).[8] The quadratic functional form is consistent with the notion that central banks view large deviations from the targets as disproportionately more costly than small variations. The weights on the various elements in the function imply that the central bank cares equally

3. This summary is based in part on Coletti, Lalonde, and Muir (2008a), which is forthcoming in a special issue of IMF Staff Papers on the International Monetary Fund's Global Economy Model (GEM) and its applications (2008). For a more complete technical description, see Coletti, Lalonde, and Muir (2008b).

4. Similarly, it is also assumed that workers offer differentiated skills to the labour market, as in Erceg, Henderson, and Levin (2000). For a more thorough non-technical description of the model, see CLM (2008b).

5. One notable shortcoming of the model is that it does not explicitly incorporate a commodities sector. Commodities are particularly important for understanding the evolution of Canada's terms of trade. This is an area for future work.

6. Although all shocks are considered to be temporary, they can be quite persistent (e.g., productivity shocks). Specific details on the shocks can be found in CLM (2008a, b).

7. An alternative approach to evaluating the merits of different monetary policy frameworks is to choose rules that maximize the welfare of the model's representative consumer. An important advantage of this approach is that it allows us to analyze which variables should be stabilized by monetary policy. On the downside, it also means that the welfare function will be model specific.

8. The output gap is the difference between the economy's actual output and the level of output that it can achieve with existing capital, the level of total factor productivity, and the trend in total hours worked.

about inflation and the output gap. The small weight on the change in the policy rate eliminates rules that cause the nominal interest rate to hit the zero lower bound more than five per cent of the time.[9]

We assume that the central bank commits to setting the contemporaneous policy interest rate, R, according to the simple rule:

$$R_t = \rho R_{t-1} + (1-\rho)R^* + \varphi_p(E_t p_{t+k} - \eta E_t p_{t+k-1} - p^T_{t+k} + \eta p^T_{t+k-1}) + \varphi_y(ygap_t), \quad (2)$$

where R^* reflects the sum of the average real short-term interest rate and the trend inflation rate, p denotes the logarithmic level of consumer prices, and E_t denotes expectations made in period t.[10] For IT, $\eta = 1$ while for PLT, $\eta = 0$. The central bank chooses the weight on interest-rate smoothing (ρ), the degree to which it reacts to expected deviations of consumer price inflation (or the price level) from target (φ_p), the degree to which it reacts to the output gap (φ_y), and the degree to which policy is forward looking (k) to minimize the objective function given in (1).

The model's parameters were chosen to allow it to closely replicate some of the key features of the Canadian and U.S. economies.[11] Of particular significance is the model's ability to replicate the persistence of consumer price and wage inflation over the sample period. The calibration is notionally consistent with assuming that about 40 per cent of firms and consumer-workers (rule-of-thumb agents) form inflation expectations based exclusively on last period's inflation rate. The remaining 60 per cent (forward-looking agents) are assumed to form their inflation expectations in a more forward-looking manner by taking into account all of the available information, including the structure of the economy, the realization of shocks, and the behaviour of the central bank.

Results

Based on a set of macroeconomic shocks similar to those seen over the 1983– 2004 period, CLM show that PLT generates slightly greater macroeconomic stability than IT in terms of minimizing the weighted average of consumer price inflation, the output gap, and nominal interest rate variability in Canada (Table 1). To be more precise, PLT delivers a reduction in the variability in consumer price inflation and nominal interest rates at the expense of slightly higher variability in the output gap.

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From Table 1, we can also see that the quantitative difference between the two monetary policy frameworks is quite small (0.5 per cent) when measured relative to the gain in moving from an historical Taylor (1993) rule to the optimized IT rule.[12] It is important to remember, however, that the preferred IT rule puts a very high weight on interest-rate smoothing (Table 2). All else being equal, as this weight approaches 1, the inflation-targeting central bank acts increasingly like a price-level targeter. A weight of 1 on the lagged inter-

Table 1

Macroeconomic Stabilization

	Inflation targeting (IT)	Price-level targeting (PLT)
Loss function*	2.15	2.13
Incremental benefit**	–	0.5%
Standard deviations of key variables under the optimized rules		
Consumer price inflation	0.50	0.41
Output gap	1.34	1.37
Interest rate (change)	1.09	1.02

* Because of rounding, the results for the aggregate loss function may not correspond to the sum of its parts.

** Incremental benefit of moving from the optimized IT simple rule to the optimized PLT simple rule relative to the gain from moving from the historical Taylor rule to the optimized IT simple rule.

9. This calculation is based on the assumption that the average real interest rate equals 3 per cent and the trend inflation rate equals 2 per cent.

10. Our analysis is restricted to consumer prices in the monetary reaction function. It may be preferable to target an alternative price index (e.g., non-tradable goods prices), particularly in the case of PLT. Examining which index is best to target is the subject of ongoing research.

11. Real data are detrended using a Hodrick-Prescott (H-P) filter with a stiffness parameter of 10,000. All Canadian nominal variables are detrended using the inflation target after 1991 and the implied inflation target calculated from the Bank of Canada's staff economic projection over the 1983–90 period (Amano and Murchison 2005). All U.S. nominal variables are detrended using an estimate of the implied inflation target in the United States (Lalonde 2005).

12. See CLM (2008b) for further details on the Taylor rules used to calibrate the model over history.

Table 2

The Optimized Simple Policy Rules

	Inflation targeting (IT)	Price-level targeting (PLT)
k	2	3
ρ	0.97	0.85
φ_p	2.44	3.74
φ_y	0.70	0.85

est rate would imply that nominal interest rates would continue to rise as long as inflation remained above target, resulting in a reversal of the initial shock to the price level. It is also interesting to note that the amount of interest rate smoothing suggested by the model is much greater than that typically found in empirical estimates of simple IT rules.[13]

To better understand the robustness of these results, CLM conduct two main sensitivity analyses. The first confirms findings in the existing literature that the relative ability of PLT versus IT to stabilize the macroeconomy depends on the degree to which prices are determined in a forward-looking manner. The more forward-looking price-setting becomes, the easier it is for the central bank to make a credible commitment to use PLT to reduce inflation variability without inducing excessive cycling in the real economy. We calculate that if the proportion of rule-of-thumb price- and wage-setters were increased from 40 per cent to 50 per cent, IT would be preferred to PLT. Based on more recent data, however, it is more reasonable to assume that a lower proportion of agents would form inflation expectations based on lagged inflation. In fact, focusing on the very low level of persistence in price and wage inflation over the inflation-targeting period in Canada would lead us to conclude that the proportion of rule-of-thumb price- and wage-setters was likely closer to zero than to 40 per cent. Even more convincing evidence from Levin, Natalucci, and Piger (2004) shows that, over the 1994–2003 period, private sector inflation expectations in Canada (and other inflation-targeting countries) have been decoupled from lagged inflation. In addition, the proportion of nominal wage contracts in Canada with a cost-of-living adjustment to past inflation has declined to about 10 per cent in recent years, from about 25 per cent in the 1980s (Fay and Lavoie 2002).[14] Such a reduction in the proportion of rule-of-thumb price- and wage-setters would strengthen the case for PLT.

The relative performance of the alternative monetary policy frameworks is also found to depend on an important interaction between the proportion of rule-of-thumb price- and wage-setters and the relative incidence of shocks. Specifically, as long as there is a significant proportion of rule-of-thumb price- and wage-setters, the relative importance of the different shocks to the economy matters for the overall results.

In the base-case calibration, PLT is preferred to IT in the case of shocks to the economy that cause consumer price inflation and the output gap to move in the same direction, such as domestic demand shocks and all foreign shocks (type A shocks).[15] On the other hand, IT generates more macroeconomic stability than PLT for shocks that cause inverse movements in inflation and the output gap, such as domestic price / wage shocks (type B shocks).[16]

Although the cumulative output gap is larger under PLT, the PLT output gap has a smaller variance than that under IT.

The intuition for this result comes from considering type A and type B shocks under the assumption that there are no rule-of-thumb price- and wage-setters. First, consider a positive shock to domestic prices (a type B shock) under PLT (see Chart 3). The central bank's commitment to a target path for the price level implies that future inflation rates must be lower under PLT than under IT. As a result, the initial rise in inflation is lower than that under IT. The reduction in inflation volatility is not merely the result of the central bank's announcement of a target path for the price level. To generate the reduction in inflation volatility, the central bank creates relatively more cumulative

13. The reasons for this are interesting in their own right, but are beyond the scope of this article.

14. In addition, Amano, Ambler, and Ireland (2008) show that the degree of indexation of nominal wage contracts to lagged inflation would be lower under PLT than under IT.

15. For example, a positive U.S. demand shock leads to higher Canadian exports, a positive Canadian output gap, higher Canadian import prices, and a rise in Canadian inflation. Alternatively, a negative U.S. price (or positive U.S. productivity) shock in the non-tradable goods sector leads to a rise in the demand for labour in the United States, a higher wage, and a rise in the price of traded goods produced in the United States. In turn, a rise in U.S. traded-goods prices leads to both an increase in Canadian import prices and positive excess demand in Canada, owing to a rise in exports to the United States.

16. More formally, price and wage shocks are shocks to the degree of competition in product and labour markets.

Chart 3

A Positive Price Shock

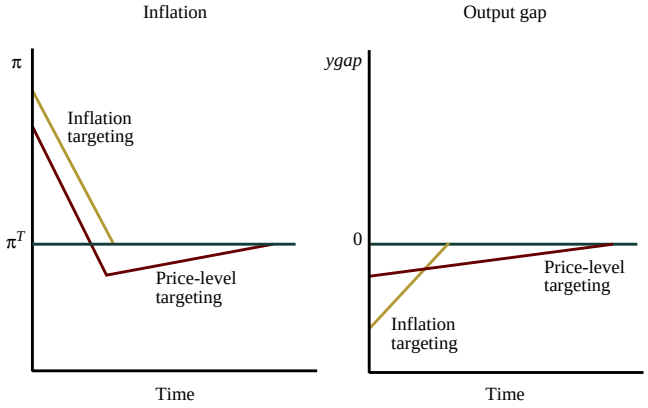
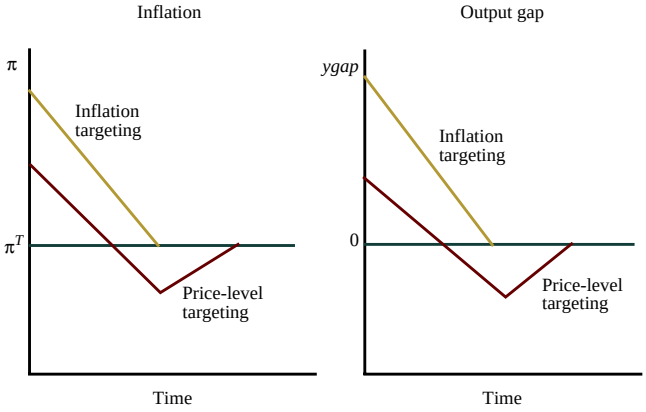


Chart 4

A Positive Demand Shock



excess supply under PLT than under IT. In fact, as long as the price level is above the target, PLT requires excess supply. Under PLT, all else being equal, the central bank will find it optimal to create less initial excess supply that lasts longer relative to IT. Taken together, this means that although the cumulative output gap is larger under PLT, the PLT output gap has a smaller variance than that under IT.[17]

Now consider a positive demand shock (a type A shock). Once again, the initial rise in inflation under PLT is smaller than under IT as a result of the central bank's commitment to a target path for the price level (Chart 4). The commitment to PLT also means that the central bank must create excess supply at some time in the future under PLT, but not under IT. In addition, the initial jump in the output gap under PLT is also smaller than it is under IT. Consequently, both the cumulative output gap and the variance of the output gap under PLT are smaller than they are under IT.

In the absence of rule-of-thumb price- and wage-setting, the relative benefits of PLT versus IT are larger for type A shocks than for type B shocks. As the proportion of rule-of-thumb price- and wage-setters rises, the central bank has an increasingly difficult time reducing inflation variability without incurring a relatively large increase in output-gap variability. When the proportion of rule-of-thumb price- and wage-setters reaches about 40 per cent, as in CLM, PLT delivers better results for both output and inflation variability in type A shocks, but IT is preferred in type B shocks. As a result, the overall assessment of the relative ability of PLT and IT to stabilize the macroeconomy depends, among other factors, on the relative incidence of type A and type B shocks.

Terms-of-Trade Shocks

We now turn our attention from the aggregate results to the specific issue of large and persistent shocks to the terms of trade. A nation's terms of trade are the price of its exports relative to the price of its imports. The evolution of Canada's terms of trade since 1961 is shown in Chart 5. Since Canada is a relatively small country on the global stage, the prices of both its imports and exports are heavily (but not exclusively) determined by developments outside of Canada. Historically, Canada's terms of trade have been most influenced by fluctuations in the world price of its key (net) exports, energy and non-energy commodities,[18] as well as movements in the world price of its key (net) imports, computers and peripheral equipment (Amano, Coletti, and Murchison 2000). More recently, falling prices of imported consumer goods from emerging economies have also boosted Canada's terms of trade (Duguay 2006; Macdonald 2007).[19]

17. Recall that the variance squares the output gap.

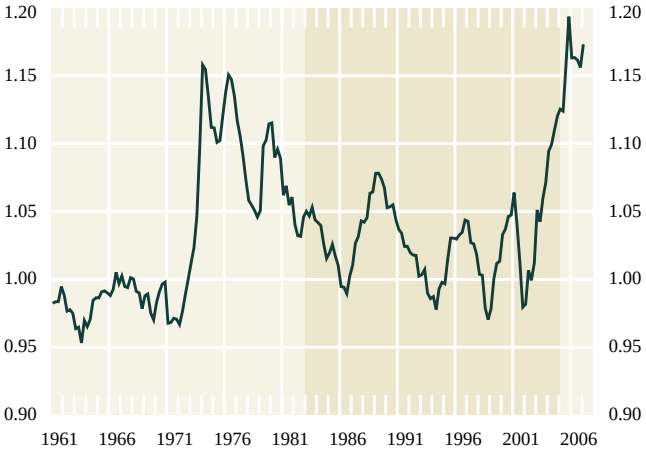
18. Commodity production represents about 11 per cent of Canadian gross domestic product (GDP), and commodity exports account for 45 per cent of the dollar value of our total exports (Duguay 2006).

19. In some cases, however, the source of the terms-of-trade shock could emanate from Canada itself. For example, there are some sectors in which developments in Canada are able to influence international prices because of the large market share enjoyed by Canadian producers (e.g., North American natural gas prices). Alternatively, Canadian producers can also face a downward-sloping demand curve in international markets because they produce a relatively differentiated product (e.g., certain automobile models, telecommunications equipment, and aircraft and transportation equipment).

Chart 5

Terms of Trade for Canada

Sample period is 1983 to 2004



Improvements in Canada's terms of trade are generally thought to have an important positive influence on the economy.[20] All else being equal, higher terms of trade means that the price of the goods Canadians sell to foreigners has gone up relative to the price Canadians pay to foreigners for their goods. On balance, Canadians receive a net transfer of wealth from our trading partners, which has two important implications for the behaviour of Canadians. First, it means that our real purchasing power has increased, thereby allowing a higher level of consumption. Second, it also means that Canadians will tend to consume relatively more imports than domestically produced goods. An improvement in the terms of trade also affects the relative level of activity in different sectors of the economy as labour and capital move into the sectors where the returns are higher.

Our special interest in terms-of-trade shocks stems from their importance for the Canadian economy and the fact that monetary policy under PLT and IT would respond differently to these shocks. Under IT, the central bank would largely ignore the initial change in the aggregate consumer price level caused by the change in the terms of trade and instead focus on returning aggregate inflation to its target. This response might involve a relatively modest change in policy interest rates with implications for the aggregate output gap and for production levels in both the tradable and non-tradable goods sectors.

20. A notable exception would be a terms-of-trade improvement resulting from a negative supply shock in a sector in which Canada enjoys important market power.

In contrast, under PLT, movements in the terms of trade could require significant changes in other relative prices in order to return the average consumer price level to target. The added inflation volatility could induce increased output variability, especially since price rigidities in the non-traded goods sector are greater than those in the traded goods sector.

Under PLT, movements in the terms of trade could require significant changes in other relative prices in order to return the average consumer price level to target.

Recall, however, that there are offsetting forces at play under PLT. As discussed earlier, a credible commitment to PLT can serve to reduce the variability of inflation relative to IT. The quantitative importance of this channel depends negatively on the proportion of rule-of-thumb price- and wage-setters and positively on the proportion of type A shocks.

It therefore becomes important to identify the sources of terms-of-trade shocks in order to quantify the relative strengths of the competing forces under PLT. An historical analysis with the stripped-down, two-country version of the GEM suggests that most of the variability in Canada's terms of trade is caused by foreign shocks, which generate a positive correlation between the output gap and consumer price inflation in Canada. In particular, the main shocks are: i) U.S. consumption shocks, ii) U.S. import shocks, and iii) exchange rate shocks.[21] Consequently, the authors find that the stabilizing effect of a credible commitment to PLT dominates the other forces at play. As a result, they conclude that PLT delivers better macroeconomic stability than does IT for shocks to Canada's terms of trade.

Conclusions and Future Work

The Bank of Canada research by Coletti, Lalonde, and Muir reviewed in this article suggests that macroeco-

21. This result may be sensitive to the specification and calibration of the model as well as to the historical time period under consideration. For example, the 1983–2004 period studied here largely ignores the large rise in Canada's terms of trade over the 2003–07 period that was driven by strong demand for commodities from emerging Asia, as well as the two major supply-driven world-oil-price shocks of the early 1970s and early 1980s. The implications of these events for the relative merits of IT and PLT are currently being studied.

nomic stability under PLT would be slightly better than under IT. In addition, when the analysis is restricted to the basket of shocks that have been identified as the most influential for the determination of Canada's terms of trade over the 1983–2004 period, PLT is found to deliver slightly better macroeconomic stability. An important result is that the relative ability of PLT and IT to stabilize the macroeconomy is quite sensitive to the fraction of rule-of-thumb wage- and price-setters in the economy and the relative incidence of the different types of shocks that can hit the economy.

Because of several important uncertainties in the analysis, the results of this research should be interpreted as merely indicative. In particular, the structure and calibration of the model are imperfect approximations of the actual economy. In addition, the relative incidence of future shocks could be very different than that seen over the 1983–2004 sample.

Considerable research is being done at the Bank of Canada to improve our understanding of the relative merits and costs of price-level targeting. This work includes extensions of the analysis reported here that focus on the special role that terms-of-trade shocks could play. Specifically, research is currently being done to study the impact of: i) including a formal commodity-producing sector in the analysis,[22] ii) examining whether the results are sensitive to allowing for permanent shocks to the terms of trade, and iii) reconsidering which index would be best to target under PLT. Lastly, since large and persistent movements in the terms of trade generate significant shifts in production and employment across different sectors and geographical regions in the economy, there is considerable interest in better understanding the implications of the relative merits of PLT and IT in incorporating the costs of reallocating capital and labour across sectors.

22. This analysis is being conducted with the Bank of Canada's version of the GEM, BoC-GEM (Lalonde and Muir 2007). BoC-GEM differs significantly from the stripped-down version of GEM used in CLM. Most notably, BoC-GEM incorporates five regions as well as energy and non-energy commodities sectors.

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