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Why Is Canada's Price Level So Predictable?

This paper draws attention to the fact that the price level in Canada—which is an inflation targeter—has strayed little from the path it would have taken had inflation never wandered off the 2% target since its introduction and has tended to revert to that path after temporary deviations. Econometric analysis using Bayesian estimation suggests that a low probability can be assigned to explaining this behavior by mutually offsetting shocks. More plausible is the assumption that inflation expectations and interest rates are determined in a way that is consistent with an element of price-level-path targeting.

JEL codes: E31, E52, E58
Keywords: inflation targeting, price-level targeting, Bayesian estimation.

CANADA WAS THE SECOND country in the world to introduce inflation targeting (IT). After 20 years in operation, the regime is largely judged as highly successful (Bayoumi and Klyuev 2007), and the inflation-control agreement between the Bank of Canada and the Government of Canada has been renewed until the end of 2016. IT regimes have now been successfully adopted in about two dozen advanced and emerging-market countries across the globe (see Batini and Laxton 2007).

While recognizing the success of IT, several academics (Svensson 1999, Cecchetti and Kim 2005) and central bankers (King 1999, Dodge 2005) have wondered whether price-level-path targeting (PLPT) might be more consistent with the mandate for price stability that most central banks have and whether it might also have better

The authors gratefully acknowledge comments and contributions by Tamim Bayoumi, Michel Juillard, Troy Matheson, two anonymous referees, and seminar participants at the IMF and the Department of Finance, Canada, as well as excellent research assistance provided by Volodymyr Tulin.

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Received February 20, 2009; and accepted in revised form April 11, 2012.

Journal of Money, Credit and Banking, Vol. 45, No. 1 (February 2013)

stabilization properties, especially in the vicinity of the zero lower bound on interest rates.[1] In November 2006, the Bank of Canada formally announced its interest in studying the benefits and costs of price-level targeting, particularly in conjunction with a lower inflation target, and launched a research program to inform its decisions on whether to change the regime in the future.

This interest has stimulated a substantial amount of research dedicated to studying the relative merits of IT and PLPT.[2] With PLPT never actually implemented,[3] the comparisons are often based on the performance of these regimes in model economies, typically of the DSGE type. These models assume pure, "textbook" versions of the two regimes.[4] Specifically, under pure IT, bygones are bygones, and the central bank always tries to bring *the inflation rate* smoothly to the target, regardless of whether the target was overshot or undershot in the past. In contrast, a PLPT central bank would aim to bring *the price level* to the path implied by the targeted rate of inflation and the initial level of the price index at the time the regime is established. This requires compensating past deviations from the targeted inflation rate by future deviations in the opposite direction.

While the difference between PLPT and IT is clear cut theoretically, it may be much less clear to market participants. According to Mervyn King (King 2000), "in the public eye there is a much less clear distinction between price level and inflation targeting than in the academic literature." In the Canadian framework, the inflation target is described as "the 2% mid-point of the 1 to 3% inflation-control range." While the Bank of Canada's Monetary Policy Reports and interest rate announcements provide broad indications about how monetary policy will guide the inflation rate to the 2% target in the future, the Bank does not publish an explicit path for the policy rate.[5] At the same time, assessments of past performance invariably emphasize that average inflation has been close to that target since it was introduced. And indeed, the behavior of Canada's consumer price index (CPI) since December 1994, when the 2% target became effective, much more closely resembles a stationary process around a constant trend than a random walk with drift, which is the process it would follow under pure IT.

1. See Laxton, N'Diaye, and Pesenti (LNP: 2006). LNP prefer the term price-level-path targeting to price-level targeting as the former explicitly recognizes that there must be a positive slope to the target path to avoid costly deflationary spirals caused by hitting the zero interest rate floor.

2. A representative sample of this work can be found in the proceedings of the Bank of Canada's conference on the *New Developments in Monetary Policy Design* held in 2007, available at http://www.cirpee.uqam.ca/BANQUE%20CANADA_CIRPEE/BDC_PAGE_WEB.htm.

3. Unless one counts a brief experiment in Sweden in the 1930s, when the authorities tried to target a *constant* price level and the world was quite different from the one we are living in today.

4. Hybrid regimes are also occasionally considered.

5. Publishing a path for the policy rate as well as all the assumptions that are used to construct the baseline forecast and confidence bands would make it considerably easier to evaluate performance from an *ex ante* perspective and allow researchers to more easily distinguish between competing interpretations of outcomes. For example, outcomes will depend critically on expectations by participants in the bond market about the systematic component of monetary policy, as this will influence the market-based interest rates and asset prices that are relevant for spending decisions. Several central banks publish the endogenous interest rate forecast paths that are used to anchor inflation in their macro projections, but the Bank of Canada is not among them.

Although such behavior may be due to luck, with positive shocks to inflation exactly offsetting negative ones over time, this paper suggests that such happenstance is very unlikely. A much more plausible explanation involves a term including the deviation of the expected price level from a targeted path in the monetary policy reaction function. This could be because the Bank of Canada is genuinely concerned about these deviations and tries to correct them or because, on the basis of the Bank's statements, market participants believe that it behaves in this way and factor these beliefs into their forecasts of interest rates and their effects on future inflation. The bank, in turn, has to take these beliefs into account in its interest-setting behavior.

To distinguish between these alternative explanations, the paper applies Bayesian estimation techniques to a model of the Canadian economy. The model is built around simple three-equation systems for Canada and the United States, connected through an interest rate parity condition and augmented with stochastic processes for equilibrium variables (such as potential output, natural rate of unemployment, neutral interest rate, equilibrium exchange rate, and the inflation target). This is a familiar, widely used model, with a relatively small number of parameters, which facilitates system estimation on a fairly short sample. This model represents a quasi-reduced form of several different structural models, so we do not have to take a position on what the "true" structure of the economy is.

Bayesian estimation has several advantages over classical estimation for the purposes of this project. It allows flexible stochastic processes and deals easily with unit roots. Bayesian estimation works better in small samples, as it facilitates bringing relevant information into the process and restricts the parameter space to plausible values. It also allows model validation and comparisons between models in terms of their plausibility, and yields useful estimates of uncertainty.

In the next section, we remind the reader of the basic differences between IT and PLPT. We then state several reasons why an IT central bank might be, or appear to be, mindful of where the price level is relative to an implied target. Section 2 introduces the model. Section 3 presents estimation results. The last section concludes.

1. DIFFERENCES BETWEEN IT AND PLPT IN THEORY AND IN PRACTICE

Under pure IT, the central bank may attempt to bring the rate of inflation smoothly back to the target without regard to historical deviations of past inflation from the target. As a result, the path that the bank envisages for inflation might never cross the target rate, but rather may converge to it gradually from above or below the target.[6] The top left panel of Figure 1 provides an example of a forecast for inflation where the initial value for inflation is 1 percentage point above the target. While the inflation rate will be stationary under IT, the price level will follow a random walk with drift,

6. Strictly speaking, this is true of "core" inflation, since headline inflation may be affected by base effects and by changes in indirect taxes.

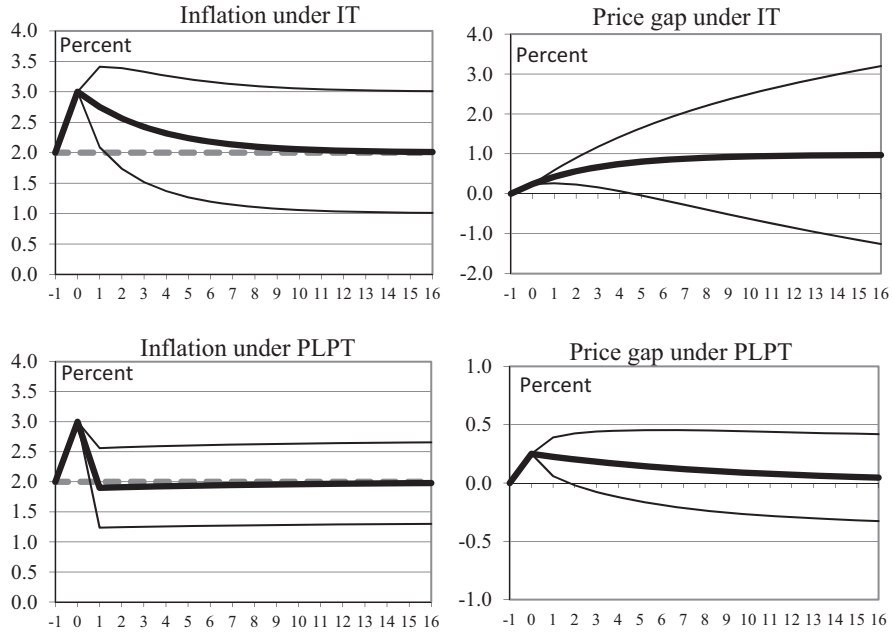

FIG. 1. Inflation Rate and the Deviation of the Price Level from Constant Growth Path after One-Period Shock under Inflation Targeting and under Price-Level-Path Targeting.

NOTE: Thin lines show illustrative confidence bands. The dashed line is the inflation target.

and the conditional forecast variance of the deviation of the price level from a path implied by a constant inflation rate will grow without bound (Figure 1, top right).

In contrast, the targeted path of inflation under PLPT depends not only on where the inflation rate currently is relative to the target, but also on where the price level is, that is, what inflation has been in the past. If both the inflation rate and the price level are initially at their respective targets, and then a shock pushes the inflation rate up, monetary policy will have to bring the inflation rate below its long-term target for some period (Figure 1, bottom left), so that the price level converges back to the target (Figure 1, bottom right). Under that regime, the deviations of the price level from the target will be mean reverting, and their forecast variances will be bounded at long horizons. Moreover, in models with significant forward-looking behavior, the unconditional variance of inflation will also be lower when the monetary authority targets a price-level path than when it targets inflation, for the same distribution of shocks and the same variability in the policy rates.[7]

7. Fillion and Tetlow (1994) find that a price-level target improves inflation control, but at the cost of increased output variability. Black, Macklem, and Rose (1997) show that this depends importantly on how expectations are formed and that when expectations are forward looking, price-level targeting can reduce the variance of both inflation and output.

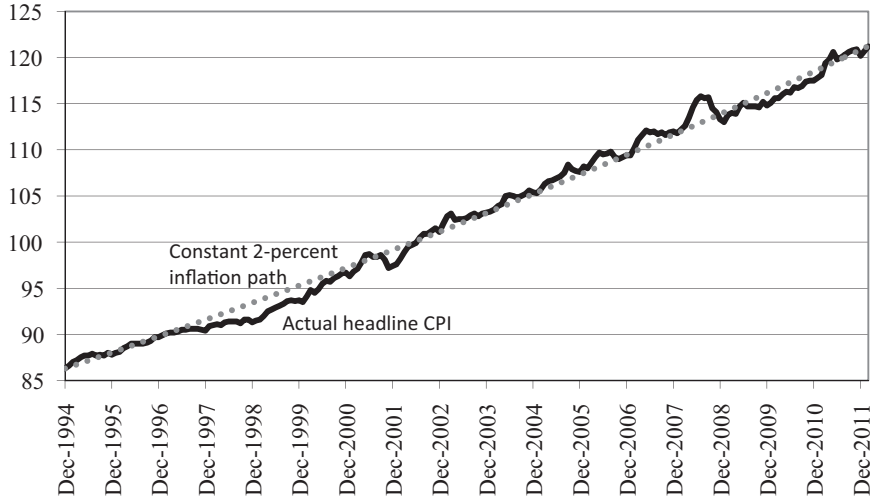

FIG. 2. Evolution of the CPI in Canada since the Introduction of the 2% Target.

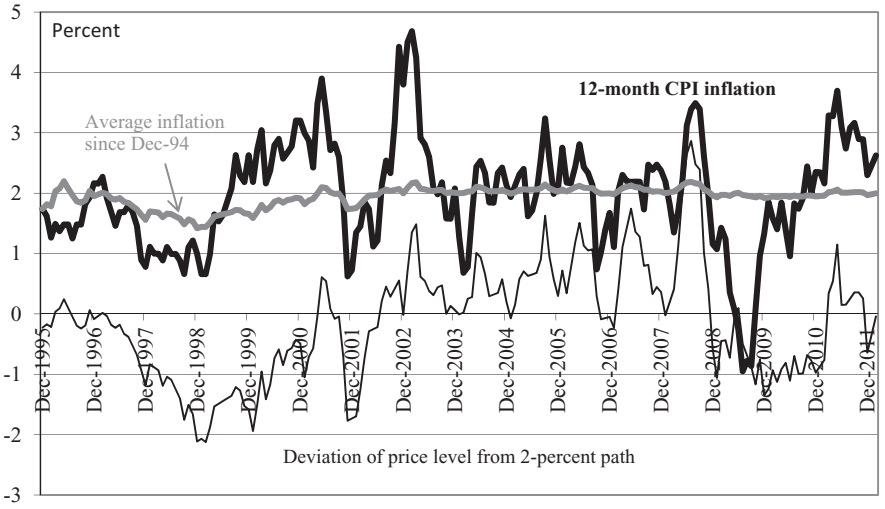

FIG. 3. Inflation and Deviation of the Price Level from the Constant Inflation Path.

If one looks at the actual behavior of the CPI level in Canada (Figures 2 and 3), it is striking how little that path has strayed from the constant inflation path and how it tends to revert to that path after temporary deviations. This fact, of course, has not escaped notice. The then-governor Dodge (Dodge 2005), when he discussed the possibility of introducing PLPT in Canada in the future, noted that the actual price level at the time was very close to what it would have been had inflation stayed

exactly on target since December 1994. He also added that under the current regime the price level might well deviate in the future from that path if a series of shocks moved inflation predominantly in one direction, implicitly ascribing the apparent mean reversion to happenstance.

While it is not impossible for the price level to be struck with almost exactly offsetting shocks over a period of nearly two decades, one would want to consider alternative explanations. For given shocks and the structure of the economy, inflation outcomes are determined by monetary policy and by market expectations of future interest rates and inflation. So it is natural to entertain a hypothesis that interest setting and expectation formation are consistent with an element of PLPT.

Why would a central bank that professes IT in fact guide the price level, perhaps over a long period, toward a certain path, or why could it be perceived as doing so by the markets? We suggest two reasons. One has to do with accountability, communication, and credibility, and the other with optimization under uncertainty.

King (1999) finds the contrast between IT and PLPT "somewhat artificial." The central bank will be perceived as doing a good job as an inflation targeter if the average inflation over the IT period has been close to the target. This backward-looking criterion is much easier to understand and verify than whether the bank is successful in targeting future inflation or the inflation forecast—a notion that is elusive and not readily verifiable. Indeed, the Bank of Canada has offered the fact that average inflation has been close to the 2% target as evidence of the success of its monetary policy (Longworth 2002). This accomplishment is also featured prominently in the *Joint Statement of the Government of Canada and the Bank of Canada on the Renewal of the Inflation-Control Target*—the highest-level document defining Canada's monetary policy regime. However, an element of PLPT would facilitate keeping inflation close to the target on average, particularly over a relatively short period.[8] Moreover, if the public expects the central bank to keep inflation rather close to the target on average, the central bank cannot ignore these expectations, as frustrating them might undermine the bank's credibility and complicate its control of the economy.

There is an important second reason for adjusting interest rates more aggressively than pure IT would suggest and pushing inflation temporarily to the other side of the inflation target after a shock. It has to do with optimization under uncertainty with an objective function where the cost of deviating from the inflation target grows more than proportionately with the deviation. Suppose that the optimal trajectory for bringing the inflation rate to the target after a temporary deviation in the absence of further shocks were the path shown by the solid black line in Figure 4. If the central bank sets its interest rate to target that path, future shocks will push inflation off that

8. For example, if deviations of the price level from the target path were white noise under PLPT while deviations of inflation from its target were white noise under IT, then under both regimes average inflation would converge over time to the target rate, but the rate of convergence would be faster under PLPT. As King (1999) observes, "asking whether the Committee had achieved an averaged inflation rate over that period would, in fact, be equivalent to price-level targeting."

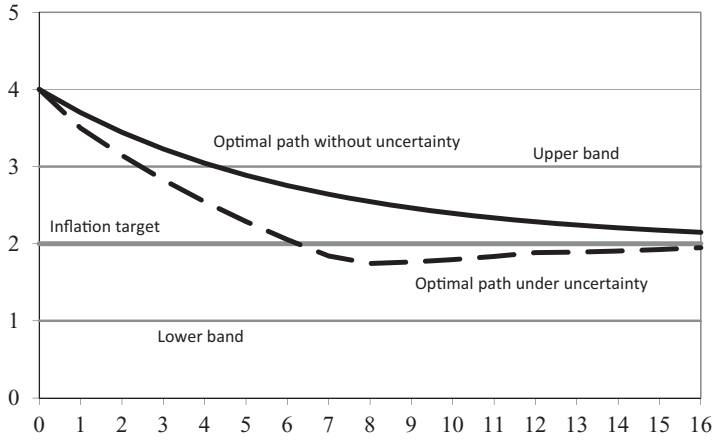

FIG. 4. Optimal Transition of Inflation to the Target with and without Uncertainty.

trajectory, and actual inflation may overshoot or undershoot the solid line. If the bank has a quadratic loss function (as is frequently assumed in the literature), or is very averse to inflation staying outside its target band, the bank will not be indifferent between overshooting and undershooting. Hence, in the presence of uncertainty (about future shocks as well as about the effects of monetary policy) it is likely to target a lower path, like the one shown by dashes, which may take inflation below the target for some time. While the projections in the Monetary Policy Report always show a smooth convergence of (core) inflation to the target from above or from below, depending on the initial position (like the solid line), most optimizing stochastic models will select a transition path with overshooting to the other side of the inflation target (like the dashed line). Hence, optimal monetary policy under uncertainty involves some correction in the price level, even if that level is not in the objective function.

A variation of this argument stresses the fact that the Bank of Canada puts an emphasis in its communications on keeping inflation within the 1–3% target band. This may lead market participants to believe that the Bank aims to keep inflation within the band a very large proportion of the time. Given that PLPT shrinks the distribution of inflation outcomes, the markets may form their expectations in a way consistent with a positive term in the price gap in the monetary policy reaction function.

2. MODEL

To test the relative likelihood of the explanations of the apparent trend-stationarity, we estimate a small model of the Canadian economy. The model is built around a

popular three-equation system: the IS curve, the Phillips curve, and a forward-looking Taylor rule.

The IS equation (1) relates Canada's output gap (y_t) to its past and expected future output gaps, the deviations of the real interest rate (r_t) and the real exchange rate (z_t) from their equilibrium values, and the U.S. output gap. The real interest rate is defined as the nominal interest rate minus expected inflation, and the real exchange rate is defined in such a way that an increase means depreciation

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t+1} + \beta_3 (r_{t-1} - \bar{r}_{t-1}) + \beta_4 (z_{t-1} - \bar{z}_{t-1}) + \beta_5 y_t^{US} + \varepsilon_t^y. \quad (1)$$

In the Phillips curve (2), the inflation rate (π_t) depends on the expected future and past four-quarter inflation ($\pi 4_{t+4}$ and $\pi 4_{t-1}$, with coefficients adding up to one), the lagged value of the output gap, and the rate of real depreciation

$$\pi_t = \lambda_1 \pi 4_{t+4} + (1 - \lambda_1) \pi 4_{t-1} + \lambda_2 y_{t-1} + \lambda_3 \Delta z_t + \varepsilon_t^\pi. \quad (2)$$

This hybrid Phillips curve differs in a few aspects from the textbook, Calvo-style New Keynesian Phillips curve (2a), where β is the subjective discount factor

$$\pi_t = \beta E_t \pi_{t+1} + \lambda_2 y_t + \varepsilon_t^\pi. \quad (2a)$$

First, it includes lagged inflation, which has been shown in numerous papers, starting with Fuhrer and Moore (1995), to be essential for replicating persistence observed in the data. While the degree of inflation persistence has declined both in Canada and the U.S. since the time of that contribution, it still remains a feature of the data, as documented by Benati (2008) and Fuhrer (2010). We take up the issue quantitatively in the next section.

Second, we have the coefficients on leads and lags of inflation sum to one, which implies that in the long run the Phillips curve is vertical and there is no trade-off between output and inflation. While we prefer that formulation, from a practical point of view the difference between the coefficients on leads and lags summing to 1 or summing to 0.99—the typical value one assumes for β at quarterly frequency—is negligible, and replacing 1 with 0.99 in equation (2) produces nearly identical results (available from the authors) and does not affect our findings.[9]

The third difference is the use of lagged output gap in equation (2). This formulation fits the data slightly better than the one with the contemporaneous gap, but it makes very little difference to our estimates and has no impact on our conclusions. This is not surprising, given the high degree of persistence in output gaps.

9. To make sure the model has a steady state with nonzero inflation target and zero output gap, one needs to replace inflation rates with their deviations from the target in equation (2) when replacing 1 with 0.99.

Finally, the textbook model is formulated for the closed economy. In a small open economy, such as Canada, exchange rate movements may exert a fairly direct impact on prices, which we try to capture in the last term of equation (2).[10]

The interest rate equation (3) takes the form of a forward-looking Taylor rule. The nominal interest rate (i_t) is a function of the past rate, the neutral real rate, expected future inflation, the output gap, and the deviations of expected inflation and the price level from their respective targets. If the coefficient γ_3 on the price level gap equals zero, we have the standard Taylor rule. If the coefficient is positive, we have a hybrid Taylor rule, which will guarantee the stationarity of deviations of the price level from the targeted path over the long run. Since bringing the price level back to the target would require more aggressive interest rate action and hence a larger swing in the output gap than bringing inflation back to the target over the same time horizon, the monetary authority is assumed to target the price level eight quarters into the future, while the horizon for the inflation target is taken to be four quarters

$$\begin{aligned} i_t = {} & \gamma_1 i_{t-1} + (1-\gamma_1)[\bar{r}_t + \pi 4_{t+4} + \gamma_2(\pi 4_{t+4} - \bar{\pi}) \\ & + \gamma_3(p_{t+8} - \bar{p}_{t+8}) + \gamma_4 y_t] + \varepsilon_t^i. \end{aligned} \tag{3}$$

To match the model to the data, we need to specify a process for potential output, so that we can add potential output to the output gap and obtain real GDP. We posit a very flexible process for potential output (equation (4)), allowing shocks to its level and persistent deviations from trend growth (equation (5))

$$\bar{y}_t = \bar{y}_{t-1} + \frac{g_t}{4} + \varepsilon_t^{\bar{y}}, \tag{4}$$

$$g_t = \tau_1 g^{ss} + (1-\tau_1)\, g_{t-1} + \varepsilon_t^g. \tag{5}$$

To help identify the output gap, we posit that it is linked to the deviations of the unemployment rate and the industrial capacity utilization rate from their equilibrium values (equations (6) and (7)), with equilibrium values following random walk processes (equations (8) and (9)):

$$u_t - \bar{u}_t = \omega_1 (u_{t-1} - \bar{u}_{t-1}) + \omega_2 y_t + \varepsilon_t^{(u_t - \bar{u}_t)}, \tag{6}$$

$$capu_t - \overline{capu}_t = y_t + \varepsilon_t^{(capu_t - \overline{capu}_t)}, \tag{7}$$

$$\bar{u}_t = \bar{u}_{t-1} + \varepsilon_t^{\bar{u}}, \tag{8}$$

10. We also estimated the model with π_{t+1} and π_{t-1} in place of $\pi 4_{t+4}$ and $\pi 4_{t-1}$, respectively, in the Phillips curve. This formulation fitted the data considerably worse than the one we employed, but the version of the Taylor rule that contained an element of price-level-path targeting was still preferred to the one without it.

$$\overline{capu}_t = \overline{capu}_{t-1} + \varepsilon_t^{\overline{capu}}. \tag{9}$$

The equilibrium real exchange rate is also assumed to be a random walk (10), while the equilibrium real interest rate follows an AR(1) process (11)

$$\bar{z}_t = \bar{z}_{t-1} + \varepsilon_t^{\bar{z}}, \tag{10}$$

$$\bar{r}_t = \rho \bar{r}^{ss} + (1-\rho)\,\bar{r}_{t-1} + \varepsilon_t^{\bar{r}}. \tag{11}$$

The U.S. economy is characterized by a similar set of equations, with a few exceptions. Specifically, there are no terms in foreign output or the exchange rate in the IS curve, the Phillips curve does not include the exchange rate term, and there is no price level target in the Taylor rule. Since the United States does not have a formal inflation target, the inflation target in the U.S. Taylor rule is assumed to follow a random walk process.[11]

Finally, the interest parity condition (12) links the U.S. and Canadian economies

$$r_t - r_t^{US} = 4\left[(\phi z_{t+1} - (1-\phi)\, z_{t-1}) - z_t\right] + \left(\bar{r}_t - \bar{r}_t^{US}\right) + \varepsilon_t^{z}. \tag{12}$$

This is a fairly standard uncovered interest parity condition, except that it incorporates an equilibrium risk premium (the second term) and allows the "expected" exchange rate to be a linear combination of the model-consistent and backward-looking expectations.[12] The factor 4 before the square brackets annualizes the expected quarterly depreciation rate, to make it consistent with the interest rate quoted on the annual basis.

3. ESTIMATION

We estimate the parameters of the system described in the previous section using Bayesian techniques on quarterly data from 1994Q4 to 2007Q2. Inflation is measured as a change in the log of the seasonally adjusted CPI, and the interest rate is the policy rate (the overnight interbank rate for Canada and the federal funds rate for the United States). We impose the following priors, based on previous work with similar models (Table 1).

The main parameters we experiment with are λ_1 (the coefficient on inflation expectations in the Phillips curve) and γ_3—the coefficient on the gap between the expected

11. This does not mean that we believe that the Fed randomly picks an inflation target every quarter. Specifying processes as a random walk allows us to accommodate slow changes in equilibrium variables without taking a position on what drives these changes.

12. For $\varphi = 1$ exchange rate expectations in the uncovered interest parity condition would be formed in a fully model-consistent way, which would give rise to a larger degree of overshooting in response to differential interest rate movements than observed in practice.

TABLE 1

PRIORS OF MODEL PARAMETERS

Param.	Mean	Distr.	St. dev.	Param.	Mean	Distr.	St. dev.
λ_2	0.25	Gamma	0.05	$\bar{r}^{ss}$	2	Normal	0.5
λ_3	0.1	Gamma	0.05	ω_1	0.8	Beta	0.1
β_1	0.75	Gamma	0.1	ω_2	0.3	Gamma	0.2
β_2	0.15	Beta	0.05	g_f^{ss}	3	Normal	0.5
β_3	0.2	Gamma	0.05	$\bar{r}_f^{ss}$	2	Normal	0.2
β_4	0.05	Gamma	0.003	β_f^1	0.75	Beta	0.1
β_5	0.3	Gamma	0.1	β_f^2	0.15	Beta	0.05
γ_1	0.75	Beta	0.05	β_f^3	0.2	Gamma	0.05
γ_2	1.5	Gamma	0.2	λ_f^1	0.4	Beta	0.1
λ_2	0.25	Gamma	0.05	λ_f^2	0.25	Gamma	0.05
γ_4	0.5	Gamma	0.05	γ_f^1	0.75	Beta	0.1
τ	0.1	Beta	0.05	γ_f^2	1.5	Gamma	0.3
g^{ss}	3	Normal	0.5	γ_f^4	0.5	Gamma	0.2
ϕ	0.6	Beta	0.2	γ_f^4	0.5	Gamma	0.2
ρ	0.2	Beta	0.07				

TABLE 2

ESTIMATION RESULTS

	Prior						Posterior					
	λ_1			γ_3			λ_1		γ_3			
	Mean	St. dev.	Distr.	Mean	St. dev.	Distr.	Mode	St. Dev.	Mode	St. Dev.	LDD	Odds
1	0.75	0.05	Beta	0.3	0.1	Normal	0.742	0.056	0.368	0.092	−425	1
2	0.75	0.05	Beta	0	0		0.783	0.056			−434	1.5×10^{-4}
3	0.25	0.05	Beta	0.3	0.1	Normal	0.336	0.093	0.234	0.119	−450	1.7×10^{-11}
4	0.25	0.05	Beta	0	0		0.292	0.060			−445	4.5×10^{-9}

NOTE: LDD is log data density. Odds are relative to case number 1.

price level and its implicit target in the Taylor rule. The metric used to evaluate how well the model (including the prior restrictions on the parameters) fits the data is the marginal data density. The ratios of the exponentials of these numbers may be interpreted as odds ratios—the relative probabilities of the models being consistent with the historical data. Given that the marginal data density function may be non-monotonic in parameters, we set fairly discrete, contrasting priors on the parameters of interest and compare the odds, rather than trying to estimate them precisely using diffuse priors.

Table 2 contains the results of our four main experiments.[13] We consider two different assumptions about how "agile" the economy is, with a high (0.75) and a

13. More detailed estimation results and impulse response functions are available from the authors upon request.

low (0.25) prior on the forward-looking coefficient λ_1 in the inflation equation.[14] In both cases the priors are quite tight, with the standard deviations of 0.05. Second, we either allow an element of price level targeting or set the coefficient γ_3 on the price level gap to zero.

Of the four cases considered, the first one fits the data by far the best. This case assumes a high weight on inflation expectations in the Phillips curve, which makes it easier for the central bank to stabilize inflation around the target without having to move the output gap too much, and an element of PLPT, with the estimated coefficient of 0.37 on the price level gap.

The model where the inflation process is as forward looking, but the price level plays no role in the interest rate setting fits the data substantially worse, with the odds of about 1 to 10,000 that the data-generating process looks like that model rather than the previous one. This tells us that chances are rather slim that a particular configuration of shocks was responsible for pulling repeatedly the price level to the path implied by a constant 2% inflation rate, without interest rates reacting to the price level gap.

Imposing a lower weight on expected inflation, thus making the Phillips curve more backward looking, results in a dramatically lower marginal data density. Comparing the posterior with the prior, one can see that the data push the estimate of λ_1 up. The data do not appear to be consistent with the notion that the Canadian economy is highly inertial. This is in line with the results of Bayoumi and Klyuev (2007), who find that the Phillips curve has become substantially more forward looking in Canada since the introduction of IT and estimate the coefficient on expected inflation at 0.71.

The case with a backward-looking Phillips curve and a term on the price-level gap in the Taylor rule fits the data particularly poorly. The reason for that is that in a highly inertial economy, interest rates would have to stay rather high (and output gap depressed) for a fairly long period of time to bring the price level back to the target after an inflationary shock. Such persistence, however, is not present in the data.

We performed a large number of robustness checks. They included changing the lag structure in equations (1)–(3), changing the horizons for the inflation target and the price level target in the Taylor rule, replacing four-quarter inflation with one-quarter inflation in the Phillips curve and in the Taylor rule, using alternative measures of short-term interest rates, restricting the sample to shorter periods, and assigning different priors (including means, standard errors, and distribution shapes) to a number of estimated parameters. In particular, both the normal and the gamma distributions were used as priors for γ_3, and the no-PLPT case was also run with a normal prior distribution around zero on γ_3 rather than simply setting it to zero as was done in our baseline. All these experiments, whose results are available upon request, confirm our basic findings.

14. We also experimented with a very high value of λ_1 (0.9), implying very little inflation persistence as in the textbook New Keynesian Phillips curve. The results were similar to those with $\lambda_1 = 0.75$. The data do not differentiate clearly among high values of λ_1, but, as shown below, they clearly reject low ones.

We conclude that the data are explained the best by a model that features a low degree of inflation persistence and a hybrid Taylor rule, with the interest rate raised by 37 basis points for 1% deviation of the price level expected eight quarters into the future from the target path. Hence, an element of PLPT in interest rate setting is a considerably more plausible explanation of the behavior of Canada's CPI since the end of 1994 than pure happenstance.

It is important to emphasize that while these empirical results strongly reject a pure IT regime in favor of a PLPT regime, it may be more difficult to distinguish between other alternative models over a small sample. Some of these competing explanations have predictions that are fairly close to PLPT. These include the following:

(i) The Bank of Canada based its interest rate setting on a view of the monetary transmission mechanism that had longer lags than what turned out to be the case *ex post*. A more inertial economy would require more aggressive interest rate responses to deviations of inflation from the target. If the economy is actually less inertial than assumed by the central bank, these aggressive responses would lead inflation to overshoot the target, just like in the case of PLPT (recall the discussion in Section 1).

(ii) Market participants believed that the Bank was trying to keep inflation inside the 1–3% bands a very high proportion of the time. This would be consistent with the Bank's communication and self-evaluation, such as statements in Longworth (2002) that "[m]onetary policy has been successful at achieving its target in most months" and that inflation uncertainty has fallen. As illustrated in Figure 1, PLPT not only produces average inflation outcomes that are close to the target, but it also shrinks the unconditional distribution of inflation relative to a pure IT regime, where bygones are bygones.

(iii) The price level gap may be simply a proxy for a nonlinear reaction function. On the upside the Bank may be concerned that persistent deviations above the 3% upper band may damage credibility and as a consequence it might respond more aggressively in such circumstances. On the downside the Bank may be concerned that persistent deviations below the 1% lower band risk flirting with deflation, which may also justify a more aggressive policy response. Both of these types of policy responses might be associated with some moderate overshooting to guard against the potential costs of not responding more aggressively.

4. CONCLUSIONS

Our results suggest that interest rate setting in Canada since the mid-1990s has been consistent with a hybrid monetary policy rule, putting some weight on the deviations of inflation from the target and some on the deviations of the price level from the path implied by that target. This rule implies that bygones are not completely bygones, and the price level is (trend-) stationary in the long run. The alternative

explanation, whereby the shocks that buffeted the Canadian economy over that period just happened to offset one another over time, so the price level only appears to be stationary, has fairly little likelihood.

One reason why the Bank of Canada may be pursuing price stability (with a constant drift), or may be believed to be doing so by the markets is the perception that the average inflation should be close to the target if the Bank is doing a good job—a criterion in fact close to price level targeting. Another explanation could be that market participants believe that the Bank aims to keep inflation within the target band a large portion of the time—a goal whose achievement would be facilitated by targeting a price-level path. Our analysis is not designed to uncover the reason or differentiate between the central bank's behavior and market beliefs.

This paper does not take a stand on whether PLPT is preferable to IT. Our results suggest, however, that should the Bank of Canada make a formal switch to PLPT, this step would likely be perceived by the markets as being an incremental innovation given that past outcomes have not been inconsistent with it. Consequently, the credibility of the existing regime would likely carry over to the new regime, and the transition should involve little disruption.

Another way to interpret our results is that to the extent that there are benefits to PLPT relative to IT, the Bank of Canada may be reaping some of them already. At the same time, a formal announcement may still be beneficial. In particular, the potential benefits of PLPT may be particularly valuable in case of a large deflationary shock, when a commitment to higher inflation in the short run raises inflationary expectations and lowers the *ex ante* real interest rate substantially without the central bank having to move the nominal rate too close to the zero bound. A formal commitment that institutionalizes this feature may be advantageous given that the specter of deflation has risen more than once over the past decade.

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