Has Inflation Targeting Improved Monetary Policy? Evaluating Policy Effectiveness in Australia, Canada, and New Zealand

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ABSTRACT

Doubts continue to be expressed about the net benefits of announcing an explicit inflation objective versus a more balanced set of goals that include an overt concern over real economic developments. This is true even if major central banks that do not explicitly target inflation (e.g., the US Fed, the ECB) emphasize the primacy of price stability as the *sine qua non* of monetary policy.We estimate a canonical macro model for each one of the three countries considered to be at the vanguard of the inflation targeting policy strategy, namely Australia, Canada, and New Zealand, and use the resulting estimates to derive measures of inflation pressure relying on two counterfactual experiments. The first asks what inflation would be if the monetary policy instrument had remained unchanged. Next, we ask what inflation rate would be obtained if the actual policy implemented by the central bank had been a surprise. Comparisons of the two scenarios suggest an indicator of monetary policy effectiveness. We also contrast our findings with evidence from the US (Siklos and Weymark 2008). Briefly, we find that, in all three of inflation targeting economies, the policy regime has succeeded in keeping inflation pressure substantially lower than in the US. In addition, inflation targeting central banks are less likely to require changes in the policy rate to accomplish a given reduction in inflation pressure than does the U.S. Federal Reserve.

Keywords: inflation targeting, inflation pressure, counterfactual experiments

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1. Introduction

Inflation targeting (hereafter IT) in various forms has spread around the world and, unlike the Bretton Woods standard, it remains so far a durable monetary policy regime (Rose 2007). Nevertheless, there continue to be doubts expressed about the net benefits of announcing an explicit inflation objective versus a more balanced set of goals that include an overt concern over real economic developments (e.g., Kohn 2007). This is true even if major central banks that do not explicitly target inflation (e.g., the US Fed, the ECB) emphasize the primacy of price stability as the *sine qua non* of monetary policy.

Even the most ardent supporters of an explicit inflation objective remain somewhat puzzled by the mixed evidence about this policy's ability, for example, to better anchor inflationary expectations than in economies where inflation is not formally targeted, such as in the US (inter alia, see Laidler (2007), Johnson (2002, 2003), Siklos (2002)), or to deliver significntly better inflationary or overall economic outcomes (e.g., Ball and Sheridan 2005).

In this paper, we estimate a small macro model for each one of the three countries considered to be at the vanguard of the IT policy strategy, namely Australia, Canada, and New Zealand, and use the resulting estimates to derive measures of inflation pressure relying on two counterfactual experiments. The first asks what inflation would be if the monetary policy instrument had remained unchanged. Next, we ask what inflation rate would be obtained if the actual policy implemented by the central bank had been a surprise. Comparisons of the two scenarios suggest an indicator of monetary policy effectiveness as well as a means of evaluating the extent to which changes in expectations occur independently of interest rate changes. This is an especially useful metric as IT's ability to anchor inflationary expectations is often touted as one of its principal advantages. Interest rate changes are then used to periodically reinforce a central bank's commitment to some pre-announced inflation objective. More generally, we find that the proposed measure of monetary policy effectiveness used in this paper has the added advantage of being applicable to a variety of economies, whether inflation is explicitly targeted or not. Finally, we also contrast our findings with evidence from the U.S. where the IT strategy has not been adopted (Siklos and Weymark 2008).[1]

Briefly, find that in all three IT economies, the policy regime has succeeded in keeping inflation pressure substantially lower than in the US. In the case of Australia, while there is evidence that IT has been successful at anchoring expectations, IT appears to have delivered fewer benefits in terms of a reduction in inflation pressure than in the other two IT regimes examined while, for Canada, inflation pressure has fallen most over time. Overall, there is substantial evidence that the IT regime has been relatively more effective than the Fed's policy framework where there is no explicit emphasis on meeting some inflation criterion. However, in some respects, the Fed's policy regime and the policies in the three IT regimes considered in this study, are not so different from each other after all, in spite of outward differences in appearances (e.g., Collins and Siklos 2004) but only if we examine estimates from the hypothesized macro model are broadly similar across all the countries considered. Actual policies suggest that IT regimes rely less on interest rate changes to accomplish a given reduction in inflation pressure.

The rest of the paper is organized as follows. The next section briefly reviews some of the debate over the relative contribution of an IT regime to overall macroeconomic performance. Section 3 outlines the approach taken wherein a measure of inflation pressure is introduced to assess the effectiveness of monetary policy over time in the three IT regimes examined in this paper. Section 4 discusses the data, presents our estimates of inflation

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[1] It is instructive to note that Greenspan (2007) does not once make reference to IT in his retrospective of his time as Fed Chairman.

pressure in the three IT countries examined here, and we also discuss the implications of our findings. Section 5 concludes.

2. The Impact of Inflation Targeting

There are at least four strands of research that deal with the economic impact of IT. Some studies consider the overall institutional environment in which inflation targets are introduced. This line of research also includes general assessments, and reviews of this regime that consider the overall performance of the central bank and the economy in this kind of policy environment. Bernanke et al. (1999), Truman (2003), Bernanke and Woodford (2005), and Mishkin (2006), summarize the debate in what has become an ever expanding literature that addresses the broader merits of a monetary policy strategy that relies on IT. What emerges from the literature is that there is considerable diversity world-wide in both the institutional, legal and, to a lesser extent, operational frameworks under which inflation targets are managed. There is no such thing as one kind of IT regime (also, see Siklos (2008)).

A separate, but quite clearly related, literature has considered the question whether inflation targets can somehow change the nature of the inflation-output trade-off, in particular whether the adoption of this kind of policy regime actually lessens the sacrifice-ratio, that is, the real costs of a disinflation. Here the evidence is decidedly mixed, with Bernanke et al. (1999) finding little evidence in favor of lower sacrifice ratios under such a regime, while Corbo et al. (2001) conclude in the affirmative. An early review of the inflation targeting literature (e.g., Neumann and von Hagen (2002)) also finds the evidence supportive of a lower sacrifice ratio under inflation targeting rather weak.

Next are studies that examine the persistence properties of inflation. Here too a large literature has emerged, and it generally finds that while inflation persistence has fallen substantially relative to the pre-IT era (e.g., Siklos 1999), it is far more difficult to identify the shift as exclusively originating with the switch-over to a regime with an explicit inflation objective. This may be because changes in the persistence properties of inflation are significant, to the extent that they are essentially a global phenomenon, and not a feature per se of the IT regime (e.g., see, inter alia, O'Reilly and Whelan (2004), Levin and Piger (2002), Benati (2008), and references therein).

The issue perhaps most germane to the objectives of this paper is the extent to which monetary policy under IT acts effectively through changes in inflation expectations. In this respect there also exists a rich literature that considers how inflation forecasts respond under a particular policy regime. Studies, such as Johnson (2002, 2003) examine the behavior of inflation expectations and forecasts over time under IT. He finds that in industrial countries the former fell significantly following the adoption of price stability objectives while the evidence concerning the impact on the latter is more mixed. In these kinds of studies it is important to carefully control for the business cycle, the general disinflationary environment, as well as for the announcements of the targets themselves. Pétursson (2004), and Vega and Winkelfried (2005), who study the behavior of actual inflation, arrive at a similarly positive assessment of the impact of IT. Lin and Ye (2007) point out that IT can be tantamount to a form of 'window dressing' because the policy simply represents an undertaking to reduce inflation in any event. The appropriate test is the counterfactual that asks what inflation would be in the absence of an IT policy. Controlling for this kind of selection bias they conclude that IT does not outperform the non-IT monetary policy in terms of inflation performance.

Finally, studies such as Gürkaynak, Levin, and Swanson (2006) examine forward interest rate behavior at high sampling frequencies to ask whether private sector perceptions of monetary policy are relatively better anchored in an IT environment than in the US experience. Based on data for the UK and Sweden, the answer seems to be in the affirmative.

3. Inflation Pressure: Measurement and Evaluation

3.1 *A Benchmark Macroeconomic Model*

We imagine the central bank as facing a trade-off between inflation and the interest rate that can be derived from a standard macro-model that is widely used in the literature and is interpreted as being akin to a canonical model (see below). Monetary policy operates through interest rate changes and these are used to offset changes in expectations, and other random shocks, that hit the economy. Conditional on these expectations, the monetary authority must decide whether or not to act the next time the policy rate is set.[2] To evaluate the effectiveness of monetary policy we ask the following hypothetical questions: what happens to inflation if the central bank does not change the policy instrument? Next, what happens to inflation if the central bank makes an interest rate move that agents did not expect? Answers to these questions require the specification of counterfactual experiments. These enable us to measure the extent to which the actual inflation rate is affected by the monetary policy actions taken, that is, both the amount of inflation that is relieved ex post and ex ante. Hence, the ex ante measure of inflation pressure effectively measures deviations from a fully anticipated policy rule. In contrast, the ex post indicator of inflationary pressure is the level of inflation given the actual interest rate setting decision taken by the central bank. To give a precise or measurable meaning to these concepts a model is, of course, required.

Clearly, the approach followed in this paper is not the only one available to us to evaluate the stance of monetary policy and the resulting pressure on inflation.[3] Nevertheless,

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[2] Implicitly, it is assumed that interest rates under the control of the central bank are set at regular, pre-announced intervals. This has been the case for several years now for all of the central banks examined in this paper, though not necessarily throughout the entire estimation sample considered. See below.

[3] There exist several monetary policy indicators in the literature. These include measures based on the specification and estimation of VARs (e.g., see Christiano, Eichenbaum, and Evans (2000), for a survey), and variants that allow for richer information sets to be employed without the need to give up some of

the definition implemented in this paper has several advantages over competing alternatives. The indicator of monetary policy effectiveness is intuitively easy to interpret as it is immediately informative about the impact of changes in the instrument of policy, here an interest rate, on inflation before and after a monetary policy decision is taken. In addition, our indicator is well-suited to evaluating the effect of monetary policy changes across countries and, indeed, across policy regimes.

We adopt an open economy version of the widely used model of Clarida, Gali, and Gertler (CGG; 1999), which is an aggregate rational expectations type model. In the present context, the model consists of four equations, namely an IS curve, a Phillips curve, an uncovered interest rate parity equation, and a Taylor rule. The IS curve written as follows:

$$\tilde{y}_t = -\beta_1[i_t - E_t\, \pi_{t+1}] + \beta_2\, E_t\, \tilde{y}_{t+1} + u_t; \quad \beta_1, \beta_2 > 0 \qquad (1)$$

where the first term is a measure of the ex ante real interest rate, $\tilde{y}_t$ is the output gap, and E_t is the expectation of the variable in question, conditional on information available at time *t*. Although the expression in equation (1) is specified in terms of a one period ahead expectation of inflation, the estimated model estimated may differ if model adequacy tests necessitate a different formulation. In particular, and as is true of the Phillips curve equation (see below), the literature has often tended to estimate IS specifications that include both backward and forward-looking elements to capture the persistence properties of key macroeconomic aggregates (e.g., see CGG 1999, Goodhart and Hofmann (2005), and references therein). Theoretically, we expect that a rise in the real interest rate reduces the current output gap,

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the advantages of restricting statistical analysis to a smaller number of time series (e.g., Bernanke, Boivin, and Eliasz 2005). Finally, there are the more narrative based approaches due to Romer and Romer (1989). The list of alternatives mentioned here is, by no means, an exhaustive one.

while output gap persistence is also assumed to be, a priori, positive, another well known stylized fact.

The second equation is a so-called hybrid Phillips curve, written as:

$$\pi_t = \alpha_1 E_t\, \pi_{t+1} + \alpha_2\, \pi_{t-1} + \alpha_3\, E_t\, \tilde{y}_{T+1} + e_t; \quad \alpha_1, \alpha_2, \alpha_3 > 0 \qquad (2)$$

where π_t is the (annualized) inflation rate. Once again the actual specification used in the counterfactuals will depend on which version of equation (2) is most congruent with the data, based on model adequacy tests. Theoretical considerations suggest inflation persistence which implies that $\alpha_2 > 0$, and that a rise in expected inflation is positively related to current inflation. Hence, $\alpha_1 > 0$. Similarly, an anticipated rise in the output gap is believed to be inflationary, so that $\alpha_3 > 0$.

Next, we add an uncovered interest parity equation since all three IT economies are, of course, small open economies. We do consider the possibility that the US, assumed here to represent the 'foreign' country, and domestic financial instruments may not be perfect substitutes. The UIP specification is, therefore, written as follows:

$$i_t = \bar{c} + i_t^* + E_t\, \Delta q_{t+1} + \mu \Delta d_t + \sigma_t \qquad (3)$$

where i_t is a nominal short-term domestic interest rate, i_t^* is a comparable U.S. interest rate, q_t is the nominal exchange rate, and *d* is the logarithm of domestic component of the money supply. In spite of how specification (3) is written we do expect that the financial assets of the countries in question are very good substitutes for similar US assets. This seems like a reasonable assumption in the present context. It is, of course, well-known that UIP can fail to hold empirically. Lothian and Wu (2003) argue, however, that this is due to the uniqueness of the decade of the 1980s which is excluded from our investigation. UIP type specifications continue, of course, to be widely used as a benchmark against which one can explain international interest rate differentials. Notice that the US interest rate and the forward exchange rate have a one to one relationship with the domestic interest rate.[4] As we shall see, while specification (3), as written here, excludes other variables, we shall consider versions that may include other variables such as interest rate or inflation changes. Finally, although the variables in (3) are contemporaneously related there is no such restriction in the empirical implementation.

The model is closed by the policy reaction function of the monetary authority, described by a Taylor rule, and expressed as

$$i_t = \gamma_0 + \rho\, i_{t-1} + (1-\rho)[\gamma_\pi\, E_t\, \pi_{t+m} + \gamma_{\tilde{y}}\, E_t\, \tilde{y}_{t+n}] + \upsilon_t; \quad \gamma_\pi, \gamma_{\tilde{y}} > 0 \qquad (4)$$

$m, n \geq 0$

where ρ indicates the degree of (positive) interest rate smoothing, and γ_π and $\gamma_{\tilde{y}}$ are the relative weights placed by the central bank on the inflation and output gaps. The Taylor principle implies that $\gamma_\pi > 1$, so that a rise in expected inflation results in a proportionately larger response in the policy rate, i_t. Theoretical considerations suggest that $\gamma_{\tilde{y}} > 0$ because a rise in the output gap, defined as actual less long-run or equilibrium output, is inflationary and prompts the monetary authority to raise the interest rate. Although many studies in the literature typically set *m* = *n*, there is no reason to do so a priori. In addition, the degree to which each central bank is forward-looking can vary, again based on estimates and model diagnostic testing. We also considered an open economy version of equation (4) by adding a real exchange rate variable. However, this variant proved not to provide better reaction function estimates (also see, in this connection, Collins and Siklos 2004). Clarida, Gali and Gertler (1998, 2002), and

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[4] Hence, we would rewrite equation (3) as: $i_t - i_t^* - E_t q_{t+1} = \overline{c} + \mu \Delta d_t + \sigma_t$.

Clarida (2001), find that while an augmented Taylor rule may be helpful empirically, the particular variable is either idiosyncratic to the country in question (e.g., a monetary aggregate for Germany) or does not fundamentally alter the general applicability of the conventional Taylor rule. Indeed, in much of the empirical literature, Taylor rules for closed and open economies are generally specified in the same manner.

3.2 *Inflation Pressure and Monetary Policy Effectiveness*

The economy is regularly subjected to shocks. These disturbances have the potential to alter inflation. Of course, changes in inflation expectations and/or the federal funds rate can offset the impact of these shocks. *Inflation pressure* can therefore be thought of as the change in inflation between meetings of the policy rate setting committee, holding constant expectations of inflation and the instrument of monetary policy.[5] Any subsequent inflationary pressure cannot be influenced by the central bank until some time in the future, due to lags in the effect of monetary policy. Since the nominal interest rate is i_t a constant interest rate over one quarter, the sampling frequency used in this study, implies that $i_t = i_{t-1}$. We, therefore, define ex ante inflation pressure (EAIP) as

$$EAIP_t = \pi_t^{\Delta i_t = 0} - \pi_{t-1} \tag{5}$$

where $\pi_t^{\Delta i_t = 0}$ is the inflation rate under the assumption that $i_t = i_{t-1}$, and π_{t-1} represents last period's inflation rate. Depending on the precise formulation of the model of inflation, the output gap, and the interest rate, ex ante inflation pressure is the inflation rate that is observed if the central bank policy rate is fixed for at least 2 quarters (or longer, if longer lags are incorporated into the model), the interest rate path is fully anticipated by economic agents, and then returns to the average policy rule thereafter. It is also implicitly assumed that interest rate

[5] We exclude from consideration interest rate changes outside the normal meeting calendar.

changes and inflation are negatively related, as this is one of the core principles of the Taylor rule. EAIP can only be observed directly in those periods when interest rates are indeed held constant *and this interest rate path is fully anticipated by economic agents.*[6] In this case, EAIP will be equal to actual inflation. In all other circumstances, EAIP must be obtained by means of a counterfactual experiment. Details of the methodology can be found in Siklos and Weymark (2008).

Consider the following scenario. Assume that the monetary authority decides to raise the policy rate. In an economy with rational, forward-looking agents, the impact of this decision will depend not only on the size of the interest rate change, but also on the effect that private agents anticipate the policy change will have on future inflation. Consequently, it is the combination of the size of the interest rate change, and the magnitude of any accompanying change in inflation expectations, that determines the effect of monetary policy on inflation. The combined effects will be reflected in whether observed inflation rates will differ from the inflation rate that would have been observed if there had been no change in policy. These observations suggest that an index measuring the extent to which monetary policy was successful in preventing EAIP from affecting observed inflation rates provides a useful indictor of the overall impact of monetary policy decisions. We call this metric the Policy Induced Change in Inflation Pressure (PIIP) defined as

$$PIIP_t = \frac{\pi_t^{\Delta i_t = 0} - \pi_t}{EAIP_t} = 1 - \frac{\Delta \pi_t}{EAIP_t} \qquad (6)$$

[6] The complexity of the solution of the specific model, under the assumption of rational expectations, is such that a closed-form solution cannot be obtained for a one period deviation from the assumed policy rule. As a result, the solution is approximated by assuming that expectations are formed based on the observed instrument rule.

The numerator in (6) is the level of inflation obtained under a no policy rate change scenario compared to actual inflation given that the central bank moves rates. Given equation (5), the PIIP can be more conveniently written as 1 less observed inflation as a fraction of EAIP. This formulation is easier to interpret. For example, when inflation is constant ($\Delta\pi_t = 0$), PIIP=1, so that $\Delta\pi_t = EAIP_t$, and the policy move was unsuccessful in moderating the impact of EAIP on actual inflation, it is also possible that the policy impact on inflation can be either larger or smaller than EAIP, producing values for PIIP that are either negative or greater than 1.[7] Hence, a monetary policy that consistently under reacts to changes in inflation expectations results in PIIP taking on negative values which is not likely to be consistent with good monetary policy. Aggressive changes in the stance of monetary policy could produce a sufficiently large reduction in inflation resulting in a PIIP that exceeds one and this case is also not straightforward to interpret. One can also think of monetary policy as displaying a form of overshooting as positive or negative values of PIIP are not consistent with good monetary policy. The interpretation of PIIP values that exceed unity is not straightforward. It is true that that a PIIP>1 suggests overshooting of the target of zero change in inflation. Hence, the central bank underestimates the impact of its policy on expectations. However, PIIP values in this range can also be identified with a purposeful effort on the part of the policy authority to alter the average inflation rate.

An important aspect of policy ineffectiveness is the degree to which the policy reduces overall inflation pressure. This leads to a definition of the effectiveness of monetary policy that is given by the ratio of ex post to ex ante inflation pressure. Ex post inflation pressure (EPIP) is the level of inflation pressure that remains after a particular monetary policy has been

[7] Given measurement error and other biases in estimates of actual inflation we exclude the possibility that EAIP=0, otherwise equation (6) is not defined.

implemented. The ratio of the two indicators is informative about the extent to which monetary policy alters the inflationary environment. We write the expression for monetary policy ineffectiveness (MPE) as:

$$MPE_t = \frac{EPIP_t}{EAIP_t} \quad (7)$$

If EPIP=0 then monetary policy is completely effective in neutralizing inflation pressure resulting in MPE=0. A monetary policy that leaves ex post and ex ante inflationary pressures equal to each other results in MPE=1. In this instance there has been no discernible impact on the inflationary environment. Less than complete elimination of inflationary pressure produces values for MPE that range between 0 and 1. As is true of the PIIP indicator, negative values for MPE as well as values that exceed 1 are also feasible. When MPE is negative, ex post and ex ante inflation pressures move in opposite directions, a clear a sign of policy ineffectiveness. In contrast, a value for MPE that exceeds one suggests that EPIP exceeds EAIP. Therefore, actual monetary policy has magnified inflation pressure and this is clearly an indication that policy is ineffective.

Both EAIP and EPIP cannot be observed. What we observe instead are the changes in interest rates and inflation rates that result from policy discussions that were actually taken. In order to measure ex post inflation pressure in terms of a single variable, we conduct a measurement experiment that converts observed changes in interest rates into inflation equivalent units. Our indicators permit us to address two additional issues that are of potential interest. These are: (1) the role played changes in inflation expectations in determining the effectiveness of monetary policy; and (2) the extent to which monetary policy is unanticipated by economic agents. EAIP measures the change in inflation that would have been observed under a fully rationally expected policy of no change in the policy rate. One the other hand, EPIP measures the inflation pressure associated with a policy decision conditional on the expectations actually held by economic agents under that policy. Consequently, the proportion of ex ante inflation pressure removed by changes in the inflation expectations of private agents can be evaluated as [1-MPE]/PIIP. The numerator in the above expression reflects the degree to which inflation pressure is altered by independent changes in expectations. [8] Note that our counterfactual EAIP measure is always calculated under the assumption of full rationality. However, EPIP is evaluated using observed variables that reflect the expectations actually held by economic agents, which may or may not be rational.[9] When, for example, individuals exhibit bounded rationality, and the central bank keeps the policy rate constant, MPE measures the extent to which monetary policy is anticipated by private agents while [1-MPE] can be thought of as capturing the surprise element of monetary policy.

4. Data and Model Estimates

4.1 Data

Quarterly data are used to estimate equations (1) through (4) for samples that begin in the 1980s for Australia, Canada, and the US, and the 1990s for New Zealand. Samples end in 2004. Details follow. Although we experimented with estimating our model in a simultaneous equations setting, we did not find that the resulting models produced substantially different results or performed better based on standard diagnostic testing (results not shown). This outcome is also consistent with much of the empirical literature.

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[8] The derivation of this expression can be found in Siklos and Weymark (2008). It has been pointed to us that there are potentially two sets of inflation pressure indicators, depending on whether a central bank makes the point by delivering a real time change in the policy rate versus a gradual change in the stance of monetary policy. Inflation pressure can, in principle, be re-evaluated each period, conditional on the steps the monetary authority actually takes. However, we make some simplifying assumptions to reduce the scope of the numerical approximations that must be made. This may indeed affect the precise measurement of inflation pressure but we believe not in any significant fashion.

[9] Our method of computing EPIP makes no a priori assumptions about the way in which expectations are formed. This point is discussed in greater details, in the context of measuring exchange market pressure, in Weymark (1998).

When forward-looking variables are present OLS is inappropriate. Therefore, following the current practice, we rely on GMM estimation. Only in those instances where contemporaneous variables produced estimates that were more congruent with the data is OLS employed.

A slightly more difficult question concerns the choice of sample period. Estimation techniques, such as GMM, typically require a reasonably long sample to obtain reliable estimates. More generally, larger samples are preferred to shorter ones from a purely statistical perspective. Of course, increasing the span of the sample also raises the likelihood that a structural break will change the parameter estimates. Figure 1 plots inflation in the three inflation targeting economies considered in the study, as well as for the US. For Australia, Canada, and New Zealand the inflation targets, or target ranges, are also shown. For the US, and by way of illustration only, a 1% - 3% range is highlighted since, during the Greenspan era, it is widely believed that such an implicit target range existed, although this assumption plays no role in the analysis that follows. Figure 2 plots the rates used in the four countries in our study. For Australia, Canada and the US, the early part of the sample reveals falling nominal rates until the early 1900s. Thereafter, interest rates are certainly volatile but stationary, at least in appearance.

For New Zealand, discontinuities in the data require that we estimate our model only over the period when inflation targets were in place, that is, beginning in 1990. All data are from the Reserve Bank of New Zealand's (RBNZ) website (www.rbnz.govt.nz). Inflation is measured in terms of the CPI-X series, which is the price level used by the RBNZ, with the government's agreement, to measure inflation. This provides us with about 15 years to data. For Australia and Canada, a larger sample is available and, in both cases, headline CPI is used to estimate quarterly inflation rates. In the case of Australia, the adoption of flexible exchange rates in the early 1980s guided the choice of 1985 as the starting point of the estimation sample, while similar considerations led us to begin estimation with Canadian data beginning no earlier than 1978. Data for Australia were obtained from the Reserve Bank of Australia (RBA; www.rba.gov.au), while for Canada they were obtained either from the Bank of Canada (BoC; www.bankofcanada.ca) or CANSIM II (Canadian Socio-Economic Information Management of Statistics Canada). For the sources of US data, see Siklos and Weymark (2008), where CPI for all urban consumers is used to estimate US inflation. The US data set essentially overlaps the period when Alan Greenspan was chairing the FOMC.

An important question of course is whether it is appropriate to rely on data prior to the actual introduction of IT. To the extent that estimation, either over a sample that includes only IT, or separate estimates for the same model pre and post-IT, produce similar results the problem does not arise. However, as one of the objectives of the paper is to determine whether an IT policy changes inflation pressure, it is useful to compare the evolution of inflation pressure over a sample that covers a period longer than when inflation control objectives were introduced. As noted above, the issue does not arise for the New Zealand case due to data limitations. For Australia and Canada, we also generated estimates for the inflation targeting sample only, using the same specifications as for the full sample, and the results were broadly comparable.[10]

Finally, a few other practical issues arise in the estimation of equations (1) through (4). First, there is the estimation of the output gap. Following usual practice, we applied an H-P filter (smoothing parameter of 1600) to the log of real GDP. We did, however, experiment with the same filter with higher smoothing parameters, as well as with quadratic and cubic de-trending but the conclusions are unaffected. The same approach is used to derive estimates for exchange

[10] The relevant results are provided in a separate appendix (results not shown).

rate changes. However, we also considered the first log difference of the exchange rate, and for the UIP relationship we also considered available estimates of the forward-premium, also obtained from the respective central bank web sites.

Second, in constructing proxies for the ex ante real interest rate we also considered several variants beginning with a one period lagged inflation rate, an arithmetic average of the last four quarters of inflation (as in Weymark and Shintani 2006), through to inflation forecasts published by the central bank, in the case of Australia and New Zealand, as well as Consensus forecasts for Canada were also employed. The results reported below make clear which variant produced the best results in econometric terms. Best is here defined as the estimates that came closest to theoretical priors concerning the signs or size of various parameter estimates, as previously discussed.

4.2 Model Estimates

Tables 1A to 1D display the coefficient estimates for equations (1) through (4), along with some diagnostic tests. Phillips curve estimates are fairly similar across all three countries with New Zealand data showing a relatively larger forward-looking coefficient than for either Australia or Canada. Similarly, the degree to which inflation is persistent (i.e., the size of the lagged inflation coefficient) is considerably lower for New Zealand data than for the other two inflation targeting economies considered. U.S. estimates are taken from Siklos and Weymark 2008; May 2004 vintage) and are reproduced in Table 1D. US results are similar to estimates for New Zealand. Clearly, since the U.S. is treated as a closed economy, no UIP equation is shown. Since the estimated models for Australia and Canada cover a longer sample than when IT is in place, we relegate to an appendix estimates when the relevant IT sample alone is considered. In the case of the Phillips curve both the forward and backward looking components of the Phillips curve are statistically comparable over the two samples for Australia (results not shown). For

Canada, the forward-looking coefficient appears to be relatively larger when the exact same specification is used. The results, however, are sensitive to the horizon specified for the forward-looking coefficient in the Phillips curve, as well as the chosen instruments.

Next, we turn to estimates of the IS curve. Output gap persistence (i.e., the lagged output gap coefficient) is smallest for New Zealand and largest for Canada. While the real interest rate response is negative for all three countries, as theory suggests, it is at least twice as large for New Zealand relative to Australia, where it was found to be statistically insignificant, and almost three times as large as the response estimated for Canada. For the US output is less persistent and more responsive to the real interest rate than in the three IT countries considered. Estimates for Australia and Canada for the IT sample only (not shown) produce almost no change for Australia while the real interest rate has a smaller, but statistically insignificant impact in Canadian data. Once again it bears repeating that exactly the same model was estimated for both samples.

Taylor rule estimates reveal very similar steady state real interest rates for all three IT countries, although the equilibrium real rate is somewhat higher for New Zealand but considerably lower for the US. Interest rate persistence is smallest for New Zealand and greatest for Australia but all estimates are compatible with other published estimates for these countries. All three central banks respond positively to the output gap though, by far, the Reserve Bank of Australia is the most responsible central bank to real economic developments. All three central banks react in accordance with the Taylor principle. However, of the three central banks, the Bank of Canada appears to be the most aggressive at responding to higher future expected inflation. Broadly speaking, US estimates resemble those for Canada. While estimation for the IT only sample for Canada and Australia yield similar results (not shown), this requires some modification in the degree to which both central banks are forward-looking. For example, in the case of the Bank of Canada, contemporaneous inflation and three quarters ahead for the output gap results in comparable steady state estimates while, for Australia, a similar Taylor rule requires the RBNZ to respond to one quarter ahead inflation and the contemporaneous output gap.

Finally, the UIP equation estimates reveal considerably more differences across the three countries, with a one-period lag specification most suitable for the New Zealand case, a contemporaneous relation works best for Australia whereas, for Canada, a specification that responds contemporaneously to domestic credit alone appears suitable to explain the Canada-US interest rate differential adjusted for the forward premium. For these particular specifications, estimation over the IT sample alone (not shown) produces almost identical results.

4.3 Indicators of Inflation Pressure and Monetary Policy Effectiveness

Figure 3 and 4, as well as Tables 2 and 3, summarize the main findings of this paper. An appendix (not shown) contains the quarter by quarter estimates of ex ante and ex post inflation pressure for each one of the three IT economies.

Table 2 provides some summary statistics showing how the mean differential between ex post and actual inflation is distributed. For Australia and New Zealand we see that a little over 50% of the time ex post inflation is below actual inflation. The record for the US is comparable while, in the case of Canada, ex post inflation tends to be above actual inflation, on average. Nevertheless, it is striking that the mean differential between actual and ex post inflation is considerably smaller in all three IT countries than it is in the US. For example, in the case of Australia, the differential never exceeds 0.04%, while the same spread is a little larger for New Zealand and Canada. For the US the range is ±1%. Therefore, actual inflation is much closer to inflation conditional on actual policy in the three IT economies than in the US. This can be interpreted as evidence favourable to the view that an IT policy is better able to anchor expectations.

Figure 3, therefore, plots our indicator of PIIP against observed inflation. The first thing to note that is that there is considerable diversity in the degree to which monetary policy is able to prevent ex ante inflation from affecting actual inflation in the four countries considered in this study. With one or two minor exceptions, monetary policy has succeeded in reducing inflation pressure in all four countries. Nevertheless, Canada's monetary policy appears to have been the most successful among the countries considered with PIIP near the value of 1 consistent with a constant inflation rate. Australia and New Zealand have a comparable record though PIIP is considerably more variable in Australia and the outcome is reflected in the relatively lower variability of New Zealand inflation.[11] The most erratic performer is the US, with several instances of overshooting followed by several periods when monetary policy under reacts to EAIP. It is conceivable that such an outcome reflects the greater scope for discretion in the US monetary policy regime which is not constrained by an explicitly announced inflation objective. Nevertheless, in spite of the variability of the PIIP indicator for the US, the overall inflation record is no less enviable than for any of the three IT countries examined here.

Indeed, if we turn to an examination of our indicator of overall monetary policy effectiveness, that is, the MPE measure shown in Figure 4 (see equation (7)), we find that while U.S. monetary policy has generally been the least effective overall, relative to the record of the three IT economies examined, the degree to which inflation has been neutralized in the U.S. has remained fairly constant through Alan Greenspan's tenure as Fed Chairman.

[11] The variance of New Zealand's inflation rate since inflation targeting was introduced is 1.56. The comparable figure for Australia, also during the period since inflation has been targeted in that country is 2.62.

Consistent with the evidence in Figure 3, Canada's monetary policy has been the most effective, followed by New Zealand with the effectiveness of Australia's monetary policy is highly variable. Nevertheless, it is interesting to note that inflation pressure in Australia is considerably higher prior to the adoption of inflation targets in 1993. Canada's monetary is also seen to become more effective over time and, again, improvements in MPE are clearly observed once inflation targets are in place beginning in 1991. Unfortunately, data limitations prevent us from commenting on New Zealand's MPE prior to the adoption of inflation targeting in 1990.

Overall, these results do point to some considerable advantage from the adoption of inflation targeting. Moreover, our conclusions do not appear to be hampered by the estimation of our macro model that includes data outside of the period when inflation targets were put into place. Finally, it is also instructive to consider the summary evidence shown in Table 3. The data reveal the extent to which expectations of inflation changed independently of interest rate changes. It is clear that much of the heavy lifting in monetary policy in the US and Australia is accomplished via changes in the policy rate. In contrast, interest rate changes prove far less necessary to influence expectations in the New Zealand and Canadian experience. This implies less variability in short-term interest rate movements in at least two or the three inflation targeting economies relative to the U.S. record.

Some central banks are considering whether an even more effective monetary policy strategy is to target the price level.[12] This policy is controversial for several reasons partly because it is unclear the extent to which bygones are bygones if a central bank were to fail a particular price level target, that is, whether the price level might be permitted to drift. In this particular scenario one can imagine that a central bank that successfully targets, say, a 2%

[12] When the Bank of Canada was last charged with continuing to target CPI inflation at 2%, one of main areas of future research outlined by the Bank, as it looked ahead to the next renewal date of 2011, was the advisability of adopting a price level target. See Bank of Canada (2006)

inflation rate would essentially be following a policy of targeting the price level but allowing for a 2% drift. Accordingly, we derived estimates of the price level, ex ante and ex post, based on our estimates of EAIP and EPIP. [13] The results lend further support for the view that, of the four countries considered in this study, Canada's IT regime was most successful at keeping inflation in check at the mid-point of the target range. Indeed, a test for cointegration between EAIP and the actual CPI, and between EPIP and the CPI, cannot be rejected for Canadian data.[14] Indeed, one cannot reject the null hypothesis that the differences in (the log of) the price levels is stationary. Subsequent estimates of a vector error correction model reveal that, on average, the underlying equilibrium inflation rate is 2%, that is, the mid-point of the inflation target range, at least since 1998. In contrast, for Australia and New Zealand, no cointegration was found between EAIP and the CPI while EPIP and the CPI are indeed cointegrated. Therefore, differences between actual and EPIP are stationary, another indication that, after the fact, the inflation targets were credible. Finally, for the US, one could not reject the null that EAIP, EPIP, and the actual CPI are independent random walks. Put differently, neither ex ante nor ex post can the Fed be thought of as a closet inflation targeting central bank.

5. Conclusions

This paper considers the role of inflation targeting as a device that is purported to improve the delivery of monetary policy, relying on a new indicator of policy effectiveness. A version of a widely used consensus macro model serves as the benchmark for the specification of counterfactual experiments that ask how inflation pressure is affected by changes in the

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[13] The relevant plots and statistical results are relegated to an appendix. Ex ante and ex post CPI levels were found from CPI(t-1)[1+EAIP(t)], and CPI(t-1)[(1+EPIP(t)), respectively.

[14] The vector {EAIP, EPIP, CPI} was tested for cointegration. In the Canadian case, the null of two cointegrating vectors could not be rejected at the 5% level of significance.

instrument of monetary policy, namely an interest rate versus changes in inflation expectations, independently of variations in the stance of monetary policy.

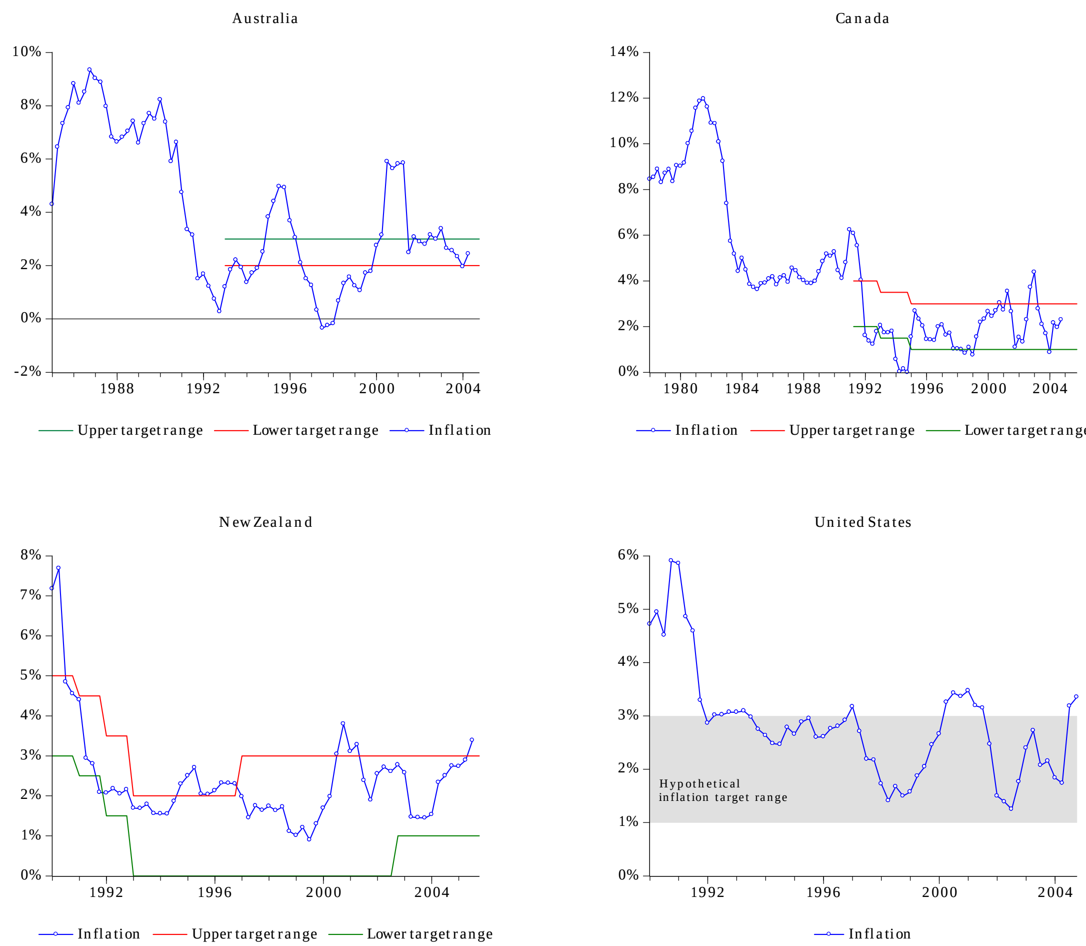
If the mere declaration of an explicit inflation target is thought by some to confer some added benefits in delivering a more effective monetary policy, it is imperative that quantitative evidence be brought to bear on the subject. After all, the record of inflation targeting relative to countries that evince a concern for inflation, but are not required to meet a publicly announced inflation goal, is decidedly mixed.

We examine the record of three inflation targeting economies, Australia, Canada, and New Zealand, against the record of the US. We find that there are considerable differences in the effectiveness of monetary policy in every country examined. What is clear, however, is that expectations of inflation are better anchored in inflation targeting regimes than in the US experience. This does not imply, however, that policy has been ineffective in the US since the inflation record in all four countries has clearly been comparable over much of the sample considered in this paper. Instead, our results suggest that changes in the policy instrument are a relatively more important instrument used in influencing inflation expectations in the US, a non-inflation targeting country. Even in some of the inflation targeting countries examined in this study, namely Australia, the policy instrument is a relatively more important tool to keep inflation in check than in the two counterpart inflation targeting economies considered here.

Our results reveal that the alleged differences in how inflation targeting is actually implemented in Australia, Canada, and New Zealand, stem from difference in our estimates of monetary policy effectiveness. For example, is Australia's inflation control regime is interpreted as being the most flexible of any of the IT countries examined in this paper, then the finding that monetary policy is relatively less effective at neutralizing changes in inflation pressure is notable. Nevertheless, it is also important to emphasize that, in all three inflation targeting countries considered, the introduction of quantified inflation objectives has delivered demonstrably more effective monetary policy. Moreover, the efficacy of monetary policy in Australia, Canada, and New Zealand, is substantially higher than is the US over roughly the same period.

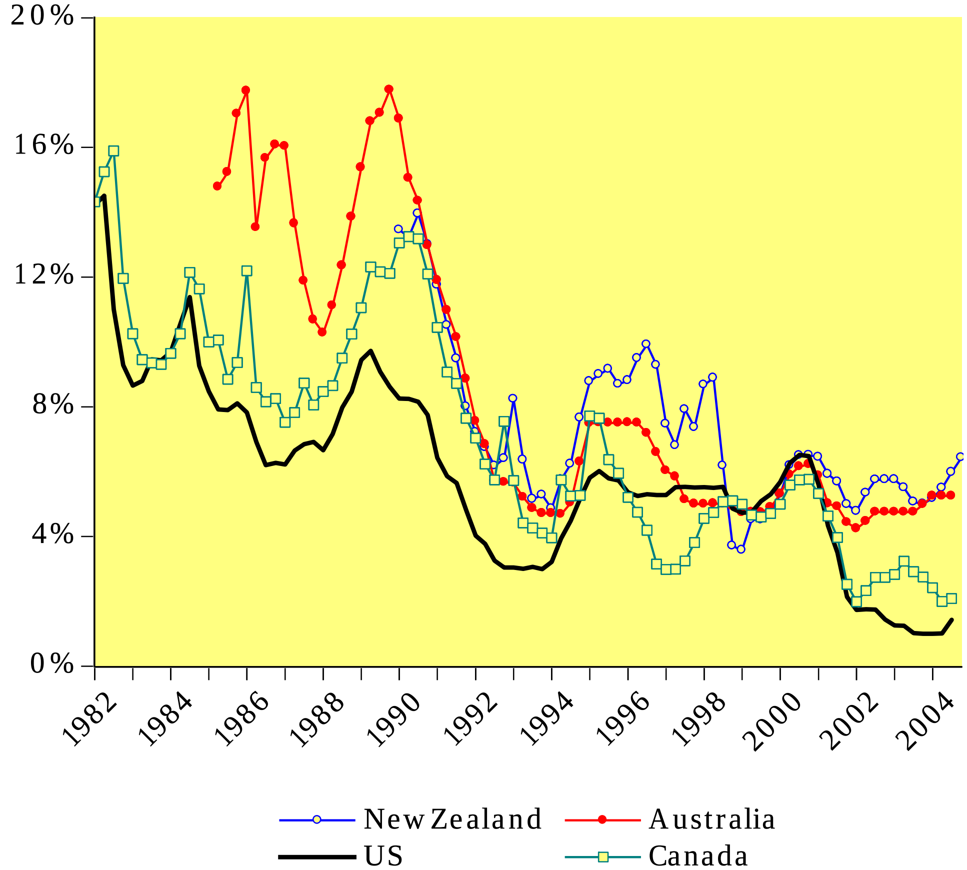
Clearly, there are several other avenues of research that need to be explored before reaching an unambiguously favourable conclusion about the desirability of a policy to explicitly target inflation. For example, the results reported here could well be sensitive to variations in the specification of the chosen macro model. Second, even if we accept the proposition that inflation targeting is better able to anchor inflationary expectations, the proposed indicators are not informative about the precise sources of the advantages conferred by setting an explicit inflation objective. These, and other extensions, are left fir future research.

Figure 1 Inflation Rates



<u>Note</u>: The horizontal lines indicate the period when inflation was formally targeted. For Australia this regime begins in 1993Q1, for Canada in 1991Q2, and for New Zealand in 1990Q1. For the US an 'implicit' target of 1-3% is shaded throughout. All data are quarterly. The text indicates which price index was used to calculate inflation.

Figure 2 Short-term Interest Rates, Quarterly Since 1982

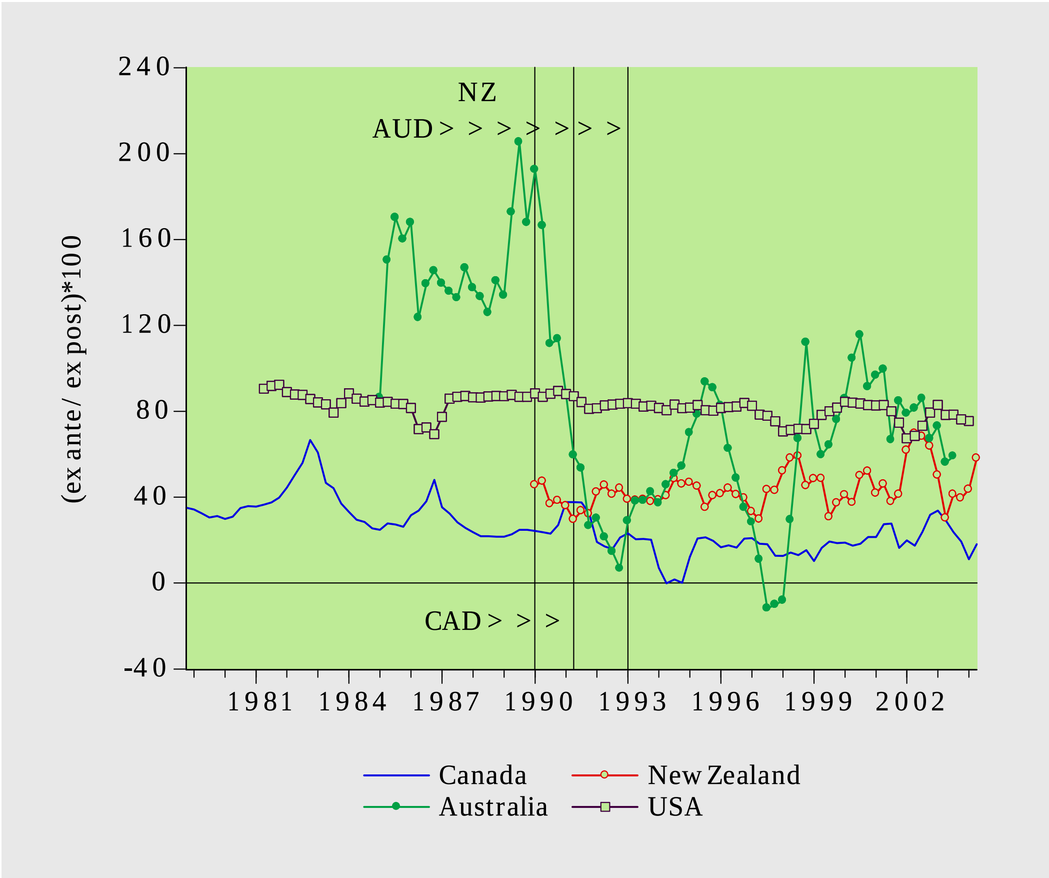


<u>Note:</u> For Canada the overnight interest rate is used, for the US the fed funds rate, for New Zealand the rate on 90 day bank bills, and for Australia the average money market rate is plotted. For Australia data begin in 1985, for New Zealand in 1990.

Figure 3 Policy Induced Inflation Pressure

Note: The left hand scale plots inflation in percent. The right hand scale if from equation (6). Definitions and sources of data are given in the text. For the US plot, 3 'outlier' values are excluded. They are: 1990Q2: 11.13, 1991Q4: -3.4, and 2003Q2: -4.4. they were excluded to ensure that both the left and right hand scales would be identical for all four countries.

Figure 4 Monetary Policy Effectiveness



Note: The figure shows inflation pressure (ex post) as a percent of inflation pressure (ex ante). For the United States the figures are from Siklos and Weymark (2008), for data from the May 2004 vintage. The vertical lines identify the start of inflation targeting in Australia (AUD), Canada (CAD), and New Zealand (NZ).

Table 1A Model Estimates: Australia

Phillips Curve

Dependent Variable: π_t

Variable	Coefficient	Std. Error	p-value.
Constant	-0.177	.249	.48
$\tilde{y}_{t-1}$	.195	.065	.004
π_{t-1}	.860	.052	.00
$\pi^e_{t\|t+4}$	.118	.062	.06
ξ_t	-.028	.010	.01
$\bar{R}^2$	0.93	LM(SC)=	.41(.52)
F	307.28	ARCH(1)=	.0001 (.99)
p-value	.00		

Note: GMM estimation with the constant, 4 lags of the output gap, the real interest rate, and the terms of trade. Bartlett kernel with a fixed bandwidth was used.

IS Curve

Dependent Variable: $\tilde{y}_t$

Variable	Coefficient	Std. Error	p-value
Constant	-0.047	.154	.76
$\tilde{y}_{t-1}$	0.795	.046	.00
$i_{t-1} - \pi^e{}_{t-1\|t}$	-0.015	.051	.77
λ_t	.040	.019	.03

$\bar{R}^2$	.80
J-statistic (p-value)	.086 (.39)

Note: OLS estimation for the sample 1993Q1-2004Q4.

Taylor Rule

Dependent Variable: i_t

Variable	Coefficient	Std. Error	p-value
Constant	5.49	.82	.00
$\tilde{y}_{t+1}$	3.54	1.50	.02
$\tilde{\pi}_{t+3}$	1.18	.90	.14
i_{t-1}	.917	.025	.00
$\bar{R}^2$	.917		
J-statistic (p-value)	.08 (.32)		

Note: GMM estimation, see previous table for details. Instruments used are 3 lags in the nominal interest rate, the output and inflation gaps, and the rate of change in the terms of trade. Sample is 1993Q1-2004Q4. Bartlett kernel with a fixed bandwidth was used. For all the variables, except the lagged interest rate, the steady state values are shown. These are found by dividing the coefficient by $1-\rho$.

Uncovered Interest Rate Parity

Dependent Variable: $(i_t - i_t^*) - (q_t - q_{t|t+1})$

Variable	Coefficient	Std. Error	p-value
Constant	.022	.133	.87

$\Delta\pi_t$	.864		.051	.09
Δi_t	-.979		.040	.00
Δq_t	-.0182		.008	.02
$\bar{R}^2$	.95	LM (SC)		.63 (.43)
F-statistic	445.24	ARCH(1)		.01 (.92)
p-value	.00			

Note: Estimated via OLS. Sample is 1993Q1-2004Q4.

Table 1B: Model Estimates: Canada

Phillips Curve

Dependent Variable: π_t

Variable	Coefficient	Std. Error	P-value.
Constant	-0.064	.069	.36
$\tilde{y}_{t-1}$	0.137	.043	.00
π_{t-1}	0.906	.045	.00
π^e_{t+3}	0.084	.049	.09
ξ_t	0.025	.009	.01
$\overline{R}^2$	.97		
J-stat (p-value)	.08 (.33)		

Note: GMM estimation with the constant, 4 lags of the output gap, the real interest rate, and the terms of trade. Bartlett kernel with a fixed bandwidth was used. Sample is 1993Q1-2004Q4.

IS Curve

Dependent Variable: $\tilde{y}_t$

Variable	Coefficient	Std. Error	p-value
Constant	0.251	.12	.05
$\tilde{y}_{t-1}$	0.929	.03	.00
$i_{t-2} - \pi^e{}_{t-2\|t-1}$	-0.0697	.03	.01
λ_t	-0.0222	.01	.08
$\overline{R}^2$	.89		

F-stat (p-value)	294 (.00)

Note: OLS estimation for the sample 1993Q1-2004Q4.

Taylor Rule

Dependent Variable: i_t

Variable	Coefficient	Std. Error	p-value
Constant	5.458	.68	.00
$\tilde{y}_{t+1}$	0.567	.68	.40
$\tilde{\pi}_{t+4}$	3.351	.77	.00
i_{t-1}	0.8966	.03	.00
$\overline{R}^2$	.91		
J-statistic (p-value)	.12 (.39)		

Note: GMM estimation, see previous table for details. Instruments used are 3 lags in the nominal interest rate, the output and inflation gaps, and the rate of change in the terms of trade. Sample is 1993Q1-2004Q4.

Uncovered Interest Rate Parity

Dependent Variable: $(i_t - i_t^*) - (q_t - q_{t|t+1})$

Variable	Coefficient	Std. Error	p-value
Constant	0.20	.06	.00
Δd_t	-0.005	.00	.23
$\bar{R}^2$	.00		
F-statistic	1.47		
p-value	.22		

Note: Estimated via OLS. Sample is 1993Q1-2004Q4.

Table 1C: Model Estimates: New Zealand

Phillips Curve

Dependent Variable: π_t

Variable	Coefficient	Std. Error	P-value.
Constant	-0.2004	.21	34
$\tilde{y}_{t-1}$	0.1132	.05	.02
$\pi_{t-1}{}^{1}$	0.6225	.07	.00
$\pi^e_{t\|t+3}$	0.4913	.14	.00
ξ_t	-0.0154	.01	.10
$\overline{R}^2$	.87		
F	109		
p-value	.00		

Note: GMM estimation with the constant, 4 lags of the output gap, the real interest rate, and the terms of trade. Bartlett kernel with a fixed bandwidth. Sample is 1993Q1-2004Q4.

IS Curve

Dependent Variable: $\tilde{y}_t$

Variable	Coefficient	Std. Error	p-value
Constant	0.8088	.38	.04
$\tilde{y}_{t-1}$	0.6559	.09	.00
$i_{t-2} - \pi^e{}_{t-2\|t-1}$	-0.1786	.07	.02

λ_t	-0.00577	.03	.03
$\bar{R}^2$	.59		
F-stat (p-value)	30.62 (.00)		

Note: OLS estimation for the sample 1993Q1-2004Q4. [1] Inflation target dummy was actually used and yielded more precise results.

Taylor Rule

Dependent Variable: i_t

Variable	Coefficient	Std. Error	p-value
Constant	6.34	.42	.00
$\tilde{y}_{t+1}$	0.814	.40	.04
$\tilde{\pi}_{t+1}$	1.381	.44	.00
i_{t-1}	0.7306	.07	.00
$\bar{R}^2$	.87		
J-statistic (p-value)	.11 (.58)		

Note: GMM estimation, see previous table for details. Instruments used are 3 lags in the nominal interest rate, the output and inflation gaps, and the rate of change in the terms of trade. Sample is 1993Q1-2004Q4.

Uncovered Interest Rate Parity

Dependent Variable: $(i_t - i_t^*) - (q_t - q_{t|t+1})$

Variable	Coefficient	Std. Error	p-value
Constant	0.266	.07	.00
$\Delta\pi_{t-1}$	0.060	.03	.04
Δi_{t-1}	-0.1652	.02	00
Δq_{t-1}	-1.4804	.86	.09
$\overline{R}^2$	.62		
F-stat (p-value)	35.32 .00)		

Note: Estimated via OLS. Sample is 1993Q1-2004Q4.

Table 1D: Model Estimates: United States

Phillips Curve

Dependent Variable: π_t

Variable	Coefficient	Std. Error	P-value.
Constant	0.1643	.1236	.20
$\tilde{y}_{t-1}$	0.0675	.0163	.00
π_{t-1} [1]	0.6872	.0412	.00
π^e_{t+4}	0.3012	.0708	.00
$\bar{R}^2$	.94		
J-statistic (p-value)	10.56 (.50)		

IS Curve

Dependent Variable: $\tilde{y}_t$

Variable	Coefficient	Std. Error	p-value
Constant	-0.0132	.0517	
$\tilde{y}_{t-1}$	0.3851	.0735	
$i_t - \pi^e{}_{t+1}$	-0.4109	.2209	
$i_{t-1} - \pi^e{}_t$	0.4404	.2078	
$E_t y_{t+1}$	0.6725	.0919	
$\bar{R}^2$	0.93 .		
J-statistic (p-value)	3.48 (.48)		

Taylor Rule

Dependent Variable: i_t

Variable	Coefficient	Std. Error	p-value
Constant	-.546	1.36	.00
$\tilde{y}_{t+1}$	1.111	0.026	.00
$\tilde{\pi}_{t+1}$	4.217	0.241	.00
i_{t-1}	0.893	0.454	.00
$\overline{R}^2$	0.90		
J-statistic (p-value)	(.80)		

Note: All results are from Siklos and Weymark (2008) for the May 2004 vintage.

Table 2 Ex post Inflation Pressure Versus Actual Inflation:

Summary Statistics

A. Australia

Range	Mean	Std. Dev.	Obs.
[-0.04, -0.02)	-0.023380	NA	1
[-0.02, 0)	-0.005182	0.005882	26
[0, 0.02)	0.004722	0.005056	14
[0.02, 0.04)	0.033411	0.001666	2
All	-0.000585	0.010883	43

B. Canada

Range	Mean	Std. Dev.	Obs.
[-0.05, 0)	-0.023293	0.020115	5
[0, 0.05)	0.021495	0.012117	46
[0.05, 0.1)	0.056285	0.006914	2
All	0.018583	0.019746	53

C. New Zealand

Range	Mean	Std. Dev.	Obs.
[-0.06, -0.04)	-0.041307	NA	1
[-0.04, -0.02)	-0.029044	0.006229	4
[-0.02, 0)	-0.007943	0.005898	25
[0, 0.02)	0.006785	0.005044	26
[0.02, 0.04)	0.023199	0.004154	3
All	-0.001865	0.013700	59

D. United States

Range	Mean	Std. Dev.	Obs.
[-1, -0.5)	-0.703223	0.104911	4
[-0.5, 0)	-0.207034	0.155794	27
[0, 0.5)	0.157315	0.131356	33
[0.5, 1)	0.697228	0.233463	2
All	-0.027530	0.307472	66

Note: The classifications above show how the differences between inflation pressure (ex post) and actual inflation are distributed. For the United States the source is as given in Figure 3.

Table 3 Changes in Inflation Expectations Independently of Interest Rate Changes

Country	Percent of observations when inflation expectations changed independently of changes in the policy rate
Australia	14.25
Canada	74.05
New Zealand	56.34
United States	0.90

Note: Figures derived from equation (7) and is evaluated as [1 – *MPE*]*100.

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