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

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Abstract

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Canada, and New Zealand

The degree to which explicit inflation targets contribute to the success of price stabilization policies has not been conclusively established. To assess the impact of announced inflation targets on the effectiveness of monetary policy, we construct indicators of inflation pressure that allow us to characterize the impact and effectiveness of monetary policy quantitatively. We examine the records of three inflation targeting economies, Australia, Canada, and New Zealand, and compare them to the US. We find that the inflation targeting countries have substantially lower inflation pressure and that inflation targeting reduces the size of interest rate changes needed to moderate inflation.

Journal of Economic Literature Classification No.: E50, E58

Keywords: inflation targeting, monetary policy, inflation pressure, stabilization policy

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, doubts continue to be expressed about the net benefits of announcing an explicit inflation objective rather than a broader set of goals that includes targets concerned with real economic developments (e.g., Kohn 2007). This is true even though major central banks that do not explicitly target inflation (e.g., the US Fed, the ECB) emphasize the achievement of price stability as the primary objective 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 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 significantly 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 construct measures of inflation pressure. We obtain our measures of inflation pressure by conducting two counterfactual experiments. The first counterfactual asks what inflation would have been if the monetary policy instrument had remained unchanged; the second asks what the inflation rate would be have been if the actual policy implemented by the central bank had been a surprise. Our first counterfactual provides us with a measure of the underlying inflation pressure that was present prior to the implementation of monetary policy. As such it provides a quantitative characterization of the inflationary environment that the policy authority faced at a given point in time. The second counterfactual measures the inflation pressure remaining after the implementation of the chosen policy intiative. We use the results of these counterfactual exercises to construct an indicator of overall monetary policy effectiveness and also to assess the extent to which changes in inflationary expectations were responsible for the impact of the monetary policy. The measure of monetary policy effectiveness that we use in this article has the advantage of being applicable to a variety of economies, whether inflation is explicitly targeted or not, which allows us to contrast our findings for the three IT countries with evidence from the U.S. where the IT strategy has not been adopted (Siklos and Weymark 2008).[1]

Using our measures of inflation pressure, we find that in all three IT economies, the policy regime has succeeded in keeping inflation pressure substantially lower than in the US. Inflation targeting has met with the greatest success in Canada, where inflation pressure has declined the most over time. In the case of Australia, while there is evidence that IT has been successful in anchoring expectations, IT appears to have delivered fewer benefits, in terms of reductions in inflation pressure, than in the other two IT regimes examined. Overall, there is substantial evidence that the three IT regimes have been relatively more effective than the Fed's policy framework, where there is no explicit emphasis on meeting some inflation criterion. If one focuses only on inflation outcomes, one might conclude that the Fed's policy regime is, despite outward differences in appearance, not very different in impact from the three IT regimes we consider (e.g., Collins and Siklos 2004). The results we obtain here indicate that the critical difference between the two types of regimes lies in the degree to which the central bank must rely on interest rate changes to accomplish a given reduction in inflation pressure. Because IT regimes are more effective in anchoring inflationary expectations, interest rate changes need not be as large or as frequent as would be required under similar circumstances in the non-IT regime.

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

[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 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 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 this 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 reduces the real costs of a disinflation, as measured by the sacrifice-ratio. 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. In an early review of the inflation targeting literature, Neumann and von Hagen (2002) also find that the evidence in support of a lower sacrifice ratio under inflation targeting is rather weak.

A third line of inquiry examines the persistence properties of inflation. Here too a large literature has emerged, and it generally finds that while there is evidence that 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, to the extent that changes in the persistence properties of inflation are significant, they are essentially a global phenomenon, and not a feature per se of the IT regime (e.g., see, inter alia, OReilly and Whelan (2004), Levin and Piger (2002), Benati (2008), and references therein).

The issue that is 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. Johnson finds that in industrial countries inflation expectations fell significantly following the adoption of price stability objectives; the evidence concerning the impact on inflation forecasts 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 dominate 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. 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 two hypothetical questions. We begin by asking what would have happened to inflation if the central bank had not changed the policy instrument. This counterfactual provides us with a measure of the inflationary environment that the policy authority faced at a given point in time, and to which it responded by implementing the observed policy initiative. We refer to this measure of inflation pressure as *ex ante* inflation pressure. Our second counterfactual, in which we ask what would have happened to inflation if the central bank had unexpectedly held the policy instrument constant, provides us with a measure of the inflation pressure that remains after the implementation of the policy initiative. This second measure of inflation pressure we refer to as *ex post* inflation pressure. The ex ante measure of inflation pressure effectively measures fully anticipated deviations from an existing policy rule. In contrast, the ex post indicator measures the strength of inflation pressure under the actual interest rate setting implemented 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

[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.

to evaluate the stance of monetary policy and the resulting pressure on inflation.[3] Nevertheless, 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 also across policy regimes.

In order to be useful for conducting the counterfactual experiments we discuss above, our model needs to have two essential features: (1) a channel of transmission through which interest changes can have an impact on inflation and (2) at least one channel by which expectational changes can potentially affect inflation. The canonical Clarida, Galí, and Gertler (CGG; 1999) aggregate rational expectations model satisfies these conditions and serves as the starting point for the country-specific empirical models we employ in this study. Because we are interested in measuring inflation pressure over a specific time period, rather than forecasting future inflation rates, we are primarily interested in specifying estimating equations that give us the best possible in-sample fit. Consequently, we use a model in which, as in the CGG model, there are forward-looking components, but, unlike the CGG model there are also lagged components and variables that explicitly capture the impact of international transactions in goods and assets on inflation and the output gap. Our benchmark model consist of four equations: an IS curve, a Phillips curve, an uncovered interest parity equation, and a Taylor rule. The benchmark IS curve is

[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 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.

written as follows:

$$\tilde{y}_t = \beta_1 E_t \tilde{y}_{t+1} - \beta_2 \left[i_t - E_t \pi_{t+1} \right] + \beta_3 [\pi_t - \Delta q_t - \pi_t^*] \ + u_t; \quad \beta_1, \beta_2 > 0 \qquad (3.1)$$

where $\tilde{y}_t$ is the output gap, i_t is the nominal interest rate, π_t is the domestic inflation rate, q_t is the nominal exchange rate (domestic currency cost of one unit of foreign currency), π_t^* is the foreign inflation rate, and E_t is the expectation of the variable in question, conditional on information available at time t. Although the expectations in equation (3.1) are expressed as one-period-ahead forecasts, the estimated model 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 β_2 to be positive, so that a rise in the real interest rate reduces the current output gap. Output gap persistence is also assumed to be, a priori, positive, so that $\beta_1 > 0$. The third coefficient, β_3 reflects the impact of the real exchange rate on the output gap; as the impact of real exchange rate changes on domestic output depends on income and export elasticities of demand, there is no strong prior for the sign of this coefficient. Note that in the canonical CGG model, $\beta_3 = 0$.

The second equation is a Phillips curve (often referred to as a hybrid Phillips curve), written as:

$$\pi_t = \alpha_1 \pi_{t-1} + \alpha_2 E_t \pi_{t+1} + \alpha_3 E_t \tilde{y}_{t+1} + \alpha_4 [\pi_t - \Delta q_t - \pi_t^*] + \epsilon_t; \quad \alpha_1, \alpha_2, \alpha_3 > 0 \quad (3.2)$$

with all variables as previously defined. Once again the actual specification used in the counterfactuals will depend on which version of equation (3.2) is most congruent with the data, based on model adequacy tests. Theoretical considerations suggest inflation persistence which implies that $\alpha_1 > 0$, and that a rise in expected inflation is positively related to current inflation so that $\alpha_2 > 0$. Similarly, an anticipated rise in the output gap is believed to be inflationary, so that $\alpha_3 > 0$.

As all three IT economies are small open economies, we add to our model an uncovered interest parity (UIP) equation. It is well-known that UIP can fail to hold empirically, but is, nevertheless, widely used as a benchmark for the purpose of explaining international interest rate differentials .[4] In order to allow for the possibility that there may be systematic country-specific deviations from UIP, we employ the following, modified UIP specification:

$$i_t = i_t^* + E_t \Delta q_{t+1} + \bar{\mu}_t + \delta_t \tag{3.3}$$

where i_t^* is a short-term foreign (US) nominal interest rate that is comparable to the domestic nominal interest rate i_t and σ_t is a random disturbance term. The variable $\bar{\mu}_t$ has been added to the standard specification to allow for country-specific deviations from UIP. In spite of the way (3.3) 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. In our empirical implementation a variety of variables, such as domestic inflation and interest rate changes, are considered as potential components of the $\bar{\mu}_t$ variable. Finally, although the variables in (3.3) are contemporaneously related there is no such restriction in the empirical implementation.[5]

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

$$i_t = \rho i_{t-1} + (1-\rho)\left[\gamma_0 + \gamma_\pi E_t \pi_{t+m} + \gamma_y E_t \tilde{y}_{t+n} + \sigma_t\right]; \quad \gamma_\pi, \gamma_y > 0,\ m, n \geq 0 \tag{3.4}$$

where ρ indicates the degree of (positive) interest rate smoothing, and γ_π and γ_y are the relative weights placed by the central bank on the inflation and output gaps. The Taylor principle implies that $\gamma_\pi > 0$, so that a rise in expected inflation results in

[4]Lothian and Wu (2003) argue, however, that the poor empirical performance of the standard UIP representation is due to the uniqueness of the decade of the 1980s which is excluded from our investigation.

[5]Notice that the US interest rate and the forward exchange rate have a one to one relationship with the domestic interest rate. Hence, we would rewrite equation (3.3) as: $i_t - i_t^* - E_t \Delta q_{t+1} = \mu_t + \sigma_t$

a proportionately larger response in the policy rate, i_t. Theoretical considerations suggest that $\gamma_y > 0$ 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 (3.4) 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, Galí and Gertler (1998, 2002), and 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

Economies are regularly subjected to shocks that have the potential to alter inflation. 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. 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. A constant interest rate over one quarter, the sampling frequency used in this study, implies that $i_t = i_{t-1}$, where i_t is the nominal interest rate in period t. We therefore define ex ante inflation pressure (EAIP) as

$$\mathrm{EAIP}_t = \pi_t^{\Delta i_t = 0} - \pi_{t-1} \tag{3.5}$$

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 periods inflation rate. Ex ante inflation pressure measures the change in inflation that would have been observed under a fully anticipated, one-period deviation from the average policy rule. Specifically, in computing ex ante inflation pressure, we conduct a policy experiment in which the interest rate is held fixed for two quarters (or longer, if longer lags are incorporated into the model) and thereafter returns to the level that is consistent with the average policy rule; economic agents are assumed to adjust their expectations accordingly. We also assume that interest rate 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. The formulae for computing EAIP will depend on the specification of the model employed to conduct the counterfactual experiment. Details of the methodology we employ to derive our EAIP measures are provided in Appendix 1.

In an economy with rational, forward-looking agents, the impact of a monetary policy initiative 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 the degree to which the observed inflation rate differs 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

[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.

of the overall impact of monetary policy decisions. We call this metric the Policy Induced Change in Inflation Pressure (PIIP) defined as

$$\mathrm{PIIP}_t = \frac{\pi_t^{\Delta i_t = 0} - \pi_t}{\mathrm{EAIP}_t} = 1 - \frac{\Delta \pi_t}{\mathrm{EAIP}_t}. \tag{3.6}$$

The numerator in (3.6) measures the difference between observed inflation and the inflation rate that would have been observed under the fully-anticipated (hypothetical) alternative policy in which the monetary authority sets $i_t = i_{t-1}$. [7] For ease of interpretation, it is convenient to express (3.6) in terms of the proportion of EAIP that is realized in the form of observed inflation. From this expression it is clear that PIIP measures the degree to which monetary policy was effective in preventing ex ante inflation pressure from being realized. The more effective is monetary policy in preventing ex ante inflation pressure from being realized, the closer is the PIIP to 1. For example, when EAIP > 0 and observed inflation is constant (i.e., $\Delta \pi_t = 0$), PIIP $= 1$, indicating that the policy initiative was successful in moderating all of the potential impact of EAIP on actual inflation. Partial moderation of the impact of EAIP on observed inflation results in PIIP values between 0 and 1. It is also possible for monetary policy initiatives to result in observed inflation changes that are of the same sign but larger than EAIP or that are opposite in sign to EAIP. Aggressive changes in the stance of monetary policy could produce a sufficiently large change in inflation as to cause $\Delta \pi_t$ and $EAIP_t$ to be of opposite sign and the PIIP value for that period to exceed 1. Negative PIIP values occur when monetary policy initiatives magnify the impact of underlying inflation pressure on observed inflation. While it is fairly clear that negative PIIP values are not likely to be consistent with good monetary policy, the interpretation of PIIP values that exceed unity is not completely straightforward. While it is true that that PIIP values larger than 1 indicate overshooting of the zero inflation change target, and would occur if the central bank had underestimated the impact of its policy initiative on expectations, PIIP values in this range can also be identified with a purposeful effort on the part of the policy

[7] Given measurement error and other biases in estimates of actual inflation, we exclude the possibility that EAIP=0, otherwise (3.6) is not defined.

authority to alter the average inflation rate.

An important aspect of policy effectiveness is the degree to which policy initiatives reduce overall inflation pressure. This leads to a definition of the monetary policy effectiveness 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 implemented.[8] 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 effectiveness (MPE) as:

$$\mathrm{MPE}_t = \frac{\mathrm{EPIP}_t}{\mathrm{EAIP}_t}. \tag{3.7}$$

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 monetary policy has had 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. Depending on one's perspective, one might consider this outcome to be indicative of policy ineffectiveness in that the policy initiative was too aggressive. However, as in the case of PIIP values that exceed unity, negative MPE values can indicate a purposeful effort on the part of the monetary authority to alter the economy's mean inflation rate. In contrast, a value for MPE that exceeds unity occurs when EPIP exceeds EAIP and both measures are of the same sign. In this case, the MPE index shows that monetary policy has magnified inflation pressure, providing clear evidence of policy ineffectiveness.

[8]EPIP cannot be observed directly. What we observe instead are the changes in interest rates and inflation rates that result from policy decisions 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. The derivation of our EPIP measure is provided in Appendix 1.

Our ex post and ex ante inflation pressure indicators permit us to address an additional issue that is of potential interest.[9] Namely, the role that changes in expectations play in determining the effectiveness of monetary policy. EAIP measures the change in inflation that would have been observed if the policy authority had held the interest rate constant and this policy initiative had been fully anticipated by rational agents. 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 $[1 - \text{MPE}]$.[10] Note that our counterfactual EAIP measure is always calculated under the assumption of full rationality whereas EPIP is evaluated using observed variables that reflect the expectations actually held by economic agents, which may or may not be rational.[11]

[9] 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.

[10] Under special circumstances, when the central bank actually does hold the interest rate constant so that EAIP is not a counterfactual, and individuals exhibit bounded rationality, MPE measures the extent to which monetary policy is anticipated by private agents. In this case, $[1 - \text{MPE}]$ can be thought of as capturing the surprise element of monetary policy.

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

4. Data and Model Estimates

4.1. Data

Quarterly data are used to estimate equations (3.1) through (3.4). The samples begin in the 1980s for Australia, Canada, and the US, and in 1990 for New Zealand; all 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. This outcome is consistent with much of the empirical literature.

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 1990s. 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 Zealands (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 governments agreement, to measure inflation. This provides us with about 15 years of 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 for 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 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.[12]

A few other practical issues arise in the estimation of equations (3.1) through (3.4). First, there is the estimation of the output gap. Following usual practice, we

[12]The relevant results are available from the authors upon request).

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 was used to derive estimates for exchange 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 which we obtained from the relevant central bank web sites.

Finally, in constructing proxies for the ex ante real interest rate we considered several variants. A one period lagged inflation rate, an arithmetic average of the last four quarters of inflation (as in Weymark and Shintani 2006), inflation forecasts published by the central bank, in the case of Australia and New Zealand, as well as Consensus forecasts for Canada were 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 5 to 5 display the coefficient estimates for equations (3.1) through (3.4), along with some diagnostic tests, for Australia, Canada, and New Zealand. Phillips curve estimates are fairly similar across all three countries with the New Zealand data showing a relatively larger forward-looking coefficient than was obtained 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 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 1E. US results are similar to estimates for New Zealand. As the U.S. is treated as a closed economy, no UIP equation is shown. For Australia and Canada the estimated models cover a longer sample than when IT is in place. For Australia, we found that both the forward and backward looking components of the Phillips curve are statistically comparable regardless of the sample length. For Canada, the forward-looking coefficient appears to be relatively larger when the specification used in the longer sample is applied to the shorter period covering only the IT period. However, the Canadian results appear to be sensitive to the horizon specified for the forward-looking coefficient in the Phillips curve, as well as the chosen instruments.[13]

We turn now 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 as compared 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 that were conducted using the IT sample only produced almost no change for Australia while the real interest rate had 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 interest rate is somewhat higher for New Zealand; a considerably lower steady state real interest rate was obtained 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 the Reserve Bank of Australia is by far the most responsive to real economic developments. All three central banks react in accordance with the Taylor principle. Of the three central banks, the Bank of Canada appears to have been the most aggressive in its response to higher future expected inflation. Broadly speaking, US estimates resemble those

[13]The estimation results obtained on the basis of the IT sample alone for Canada and Australia may be obtained from the authors upon request.

for Canada. Estimation for the IT only sample for Canada and Australia yield similar results.[14]

The UIP equation estimates reveal considerably more diversity across the three IT countries. We found a one-period lag specification to be most suitable for the New Zealand case, a contemporaneous relation to work best for Australia, whereas for Canada, the standard UIP equation provided the most satisfactory results. For these particular specifications, estimation over the IT sample alone produces almost identical results.

4.3. Indicators of Inflation Pressure and Monetary Policy Effectiveness

Figures 3 and 4, as well as Tables 2 and 3, summarize the main findings of this paper. Appendix 2 contains the quarter by quarter estimates of ex ante and ex post inflation pressure for each 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. In the case of Australia, the differential never exceeds 0.04%; for New Zealand and Canada the spread is a little larger. For the US the range is ±1%. Our finding that observed inflation is much closer to ex post inflation in the three IT economies (as compared to the US) can be interpreted as evidence that an IT policy is better able to anchor expectations.

[14] Note that the change in sample length required 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.

In Figure 3, our PIIP indicator is plotted 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 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; Canada's PIIP values are close to 1, which is consistent with a constant inflation rate. Australia and New Zealand have comparable records in terms of inflation levels, but PIIP is considerably less variable in New Zealand, an outcome that is reflected in the relatively lower variability of New Zealand's inflation rate.[15] 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. However, in spite of the variability of the PIIP indicator for the US, the inflation outcomes in the US economy appear comparable to those achieved in the three IT countries examined here. An examination of our indicator of overall monetary policy effectiveness, that is, the MPE measure shown in Figure 4 (see equation (7)), shows 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.[16]

[15]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.

[16]The fact that US outcomes are comparable to those in the IT countries despite the fact that the MPE indicator shows US monetary policy to have been the least effective suggests that the US economy had less underlying inflation pressure to deal with than the other countries did. Greenspan's (2004) comment that much of the of the Fed's success during his tenure was due to favorable economic circumstances provides some support for this observation.

The evidence in Figure 3 indicates that Canada's monetary policy has been the most effective, followed by New Zealand; the effectiveness of Australias monetary policy appears to have been highly variable. Nevertheless, it is interesting to note that inflation pressure in Australia was considerably higher prior to the adoption of inflation targets in 1993. Canada's monetary policy appears also to have become more effective over time with improvements in the MPE indicator are becoming more pronounced after the introduction of inflation targets in 1991. Unfortunately, data limitations prevent us from commenting on New Zealand's MPE prior to the adoption of inflation targeting in 1990. Overall, our results suggest that the adoption of explicit inflation targeting does enhance the effectiveness of monetary policy in reducing inflation pressure.

Finally, it is also instructive to consider the summary evidence shown in Table 3. The data reveal the extent to which changes in inflation expectations were responsible for reductions in inflation pressure. 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 New Zealand and Canada, by contrast, much of the impact of monetary policy changes occurs as a result of expectational changes, which appear to be highly responsive to relatively small interest rate movements under the IT regimes that are in place in these two countries. This implies less variability in short-term interest rate movements in at least two of 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.[17] This policy is controversial in part because it is unclear to what extent bygones are bygones if a central bank were to fail to achieve a particular price level target. That is, it is unclear whether the price level might be permitted to drift. In some situations, it might be quite difficult to tell the difference between price level and inflation targeting. For example, one could

[17]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).

argue that the inflation outcomes associated with the successful implementation of a 2% inflation target are virtually indistinguishable those that would be achieved by 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.[18] 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.[19] One also 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. In other words, neither ex ante nor ex post can the Fed be thought of as a closet inflation targeting central bank.

5. Conclusions

In this article, we assess the role of inflation targeting as a means of improving the effectiveness of monetary policy as a tool for controlling inflation. We construct indicators of monetary policy impact and effectiveness that allow us to character-

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

[19]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.

ize monetary policy performance quantitatively. We employ a modified version of a widely used consensus macro model as the benchmark for the specification of counterfactual experiments that enable us to measure the extent to which inflation pressure is affected by changes in the instrument of monetary policy, namely an interest rate, as compared to changes in inflation expectations.

Among inflation targeting countries, the announcement of explicit inflation targets is generally believed to be the key to successful price stablilzation. However, studies that have compared the effectiveness of price stabilization policies in inflation targeting countries with the outcomes achieved in countries in which there is concern for inflation but no publicly announced inflation goal, have not provided unequivocal support for this view. In this article, we offer a new approach to the quantitative assessment of the efficacy of inflation targeting.

We use indicators of ex ante and ex post inflation pressure to examine the records of three inflation targeting economies, Australia, Canada, and New Zealand, and compare them to the record of the United States. 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 United States. This does not imply, however, that policy has been ineffective in the United States. On the contrary, 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.

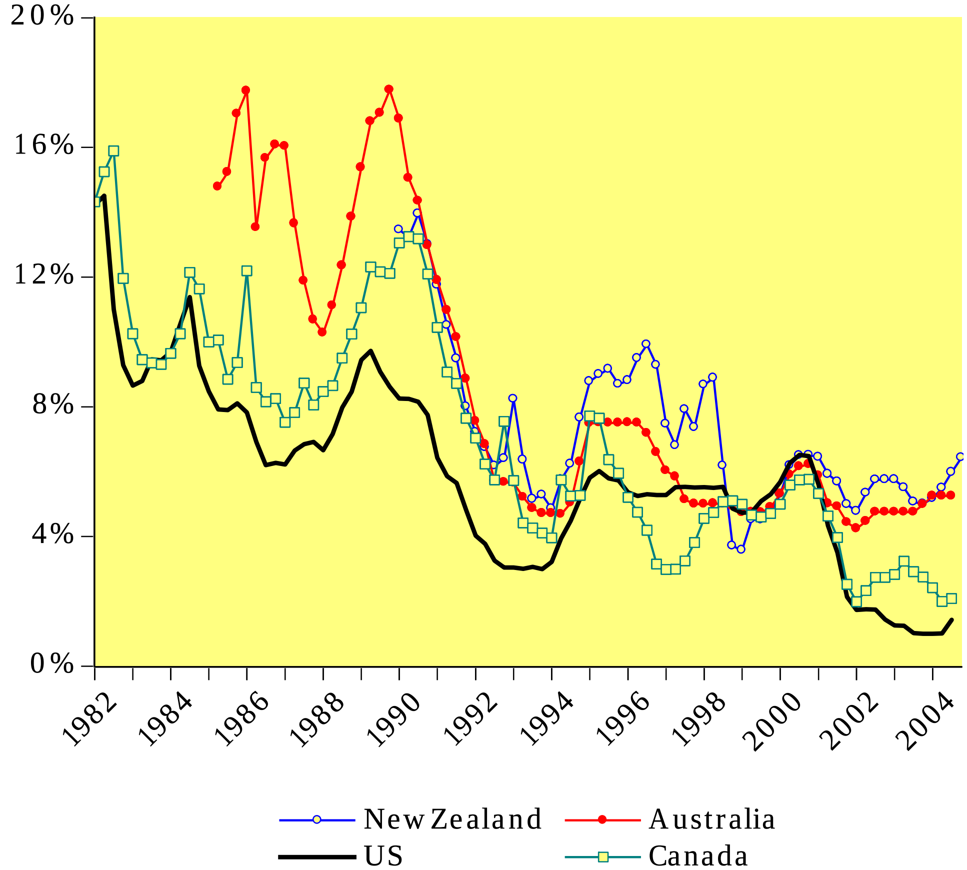
Our results suggest a systematic relationship between the way in which an inflation targeting regime is implemented and the degree to which inflation targeting enhances the effectiveness of monetary policy. For example, if one views Australias inflation control regime as being the most flexible of any of the IT countries examined in this paper, then our finding that monetary policy is relatively less effective at neutralizing changes in Australian inflation pressure suggests that flexibility in the IT regime and monetary policy effectiveness are inversely related. However, it is 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 in 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 for future research.

Figure 1 Inflation Rates

Note: 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

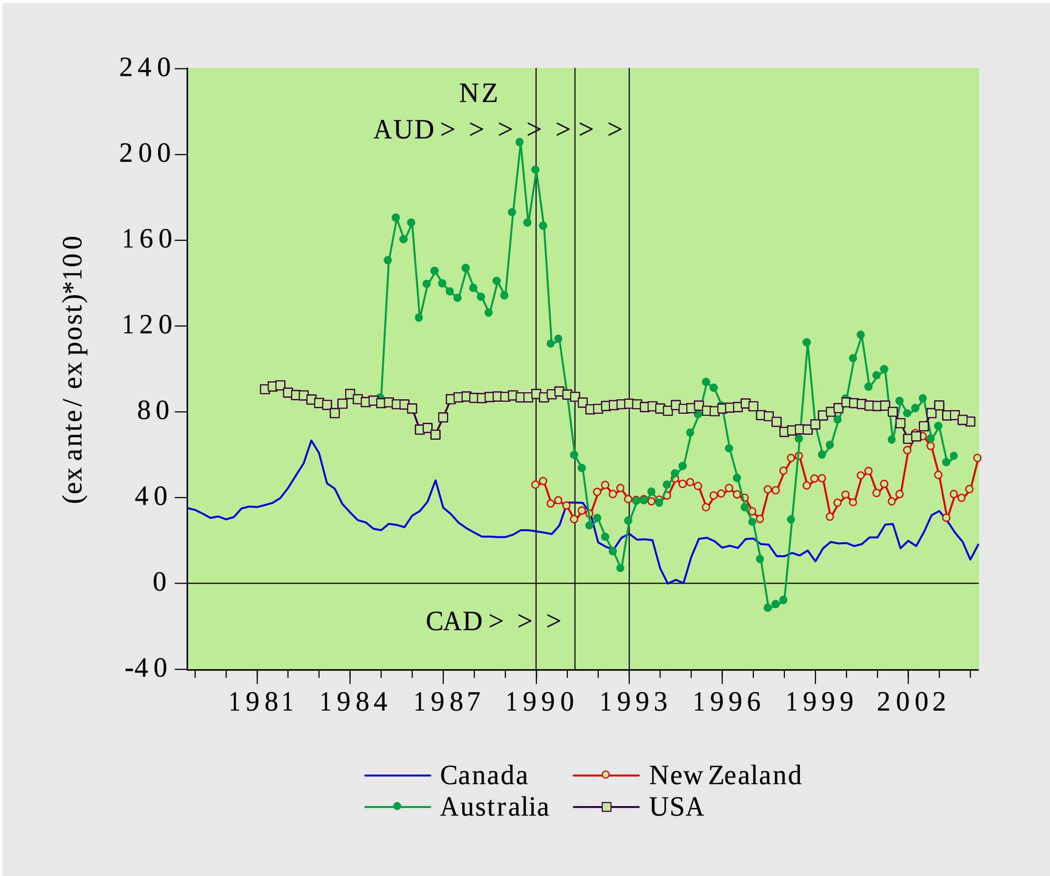


Note: For Canada the overnight interest rate is used, for the US the fed funds rate, for New Zealand the rate on 90 day bank bills, and for Australia the average money market rate is plotted. For Australia data begin in 1985, for New Zealand in 1990.

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

Phillips Curve Estimates

Sample Period: 1993Q1 – 2004Q4

Dependent Variable = π_t

Australia	const	π_{t-1}	$E_t\pi_{t+4}$	$\tilde{y}_{t-1}$	$[\pi_t + q_t - \pi_t^*]$	R^2	F-Stat	P-Value
	−0.177	0.860	0.118	0.195	−0.028	0.93	307.28	0.00
	(0.249)	(0.052)	(0.062)	(0.065)	(.010)			
Canada	const	π_{t-1}	$E_t\pi_{t+3}$	$\tilde{y}_{t-1}$	$[\pi_t + q_t - \pi_t^*]$	R^2	J-Stat	P-Value
	−0.064	0.906	0.084	0.137	0.025	0.97	0.08	0.33
	(0.069)	(0.045)	(0.049)	(0.043)	(0.009)			
New Zealand	const	π_{t-1}	$E_t\pi_{t+3}$	$\tilde{y}_{t-1}$	$[\pi_t + q_t - \pi_t^*]$	R^2	F-Stat	P-Value
	−0.200	0.622	0.491	0.113	−0.015	0.87	109	0.00
	(0.210)	(0.070)	(0.140)	(0.050)	(0.010)			

Note: Estimates were obtained using GMM with the following instruments: constant, 4 lags of the output gap, the real interest rate, and terms of trade. A Bartlett kernel with a fixed bandwidth was employed.

TABLE 1B

IS Equation Estimates

Sample Period: 1993Q1 – 2004Q4

Dependent Variable = $\tilde{y}_t$

Australia	const	$\tilde{y}_{t-1}$	$[i_{t-1} - E_{t-1}\pi_t]$	$[\pi_t + q_t - \pi_t^*]$	R^2	J-Stat	P-Value
	−0.047	0.795	−0.015	0.040	0.80	0.086	0.39
	(0.154)	(0.046)	(0.510)	(0.019)			
Canada	const	$\tilde{y}_{t-1}$	$[i_{t-2} - E_{t-2}\pi_{t-1}]$	$[\pi_t + q_t - \pi_t^*]$	R^2	F-Stat	P-Value
	0.251	0.929	−0.069	−0.022	0.89	294	0.00
	(0.120)	(0.030)	(0.030)	(0.010)			
New Zealand	const	$\tilde{y}_{t-1}$	$[i_{t-2} - E_{t-2}\pi_{t-1}]$	$[\pi_t + q_t - \pi_t^*]$	R^2	F-Stat	P-Value
	0.809	0.656	−0.179	−0.006	0.59	30.62	0.00
	(0.380)	(0.090)	(0.070)	(0.059)			

Note: Estimates were obtained using OLS. An inflation target dummy was used for New Zealand.

TABLE 1C

Taylor Rule Estimates

Sample Period: 1993Q1 – 2004Q4

Dependent Variable = i_t

Australia	const	i_{t-1}	$E_t\pi_{t+3}$	$E_t\tilde{y}_{t+1}$	R^2	J-Stat	P-Value
	5.490	0.917	1.180	3.540	0.91	0.08	0.32
	(0.082)	(0.025)	(0.900)	(1.500)			
Canada	const	i_{t-1}	$E_t\pi_{t+4}$	$E_t\tilde{y}_{t+1}$	R^2	J-Stat	P-Value
	5.458	0.897	3.351	0.567	0.91	0.12	0.39
	(0.680)	(0.030)	(0.770)	(0.680)			
New Zealand	const	i_{t-1}	$E_t\pi_{t+1}$	$E_t\tilde{y}_{t+1}$	R^2	J-Stat	P-Value
	6.340	0.731	1.381	0.814	0.87	0.11	0.58
	(0.420)	(0.070)	(0.440)	(0.040)			

Note: Estimates were obtained using GMM. Instruments used: 3 lags in the nominal interest rate, output gap, gap between inflation and announced target, and change in the terms of trade. Steady state values are shown for all variables except the lagged interest rate. Coefficients for inflation expectations and expected output gap can be obtained by dividing the reported coefficient estimate by $(1-\rho)$, where ρ is the lagged interest rate coefficient.

TABLE 1D

Uncovered Interest Parity (UIP) Estimates

Sample Period: 1993Q1 – 2004Q4

Dependent Variable for Australia & New Zealand= $[i_t - i_t^* - E_t q_{t+1} + q_t]$

Dependent Variable for Canada = i_t

Australia	const	$\Delta\pi_t$	Δi_t	Δq_t	R^2	F-Stat	P-Value
	0.022	0.864	-0.979	-0.018	0.95	445.24	0.00
	(0.133)	(0.051)	(0.040)	(0.008)			
Canada	const	$[i_t^* - E_t q_{t+1} + q_t]$	Δd_t		R^2	F-Stat	P-Value
	$- - --$	1.01	0.01		0.98	$- - --$	0.00
		(0.010)	(0.000)				
New Zealand	const	$\Delta\pi_{t-1}$	Δi_{t-1}	Δq_{t-1}	R^2	F-Stat	P-Value
	0.266	0.060	-0.165	-1.480	0.62	35.32	0.00
	(0.070)	(0.030)	(0.020)	(0.860)			

Note: Estimates were obtained using OLS with $[E_t q_{t+1} - q_t]$ proxied as the relevant currencies forward premium with respect to the US dollar.

TABLE 1E

Coefficient Estimates for the United States

Sample Period: 1980Q4 – 2004Q1

Phillips Curve	const	π_{t-1}	$E_t\pi_{t+4}$	$\tilde{y}_{t-1}$		R^2	J-Stat	P-Value
dep. var = π_t	0.164	0.687	0.301	0.068		0.94	10.56	0.50
	(0.124)	(0.041)	(0.071)	(0.016)				
IS Equation	const	$\tilde{y}_{t-1}$	$[i_t - E_t\pi_{t+1}]$	$[i_{t-1} - E_{t-1}\pi_t]$	$E_t\tilde{y}_{t+1}$	R^2	J-Stat	P-Value
dep. var = $\tilde{y}_t$	−0.013	0.385	−0.411	0.440	0.672	0.93	3.48	0.48
	(0.052)	(0.074)	(0.221)	(0.092)				
Taylor Rule	const	i_{t-1}	$E_t\pi_{t+1}$	$E_t\tilde{y}_{t+1}$		R^2	J-Stat	P-Value
dep. var = i_t	−0.546	0.893	4.217	1.111		0.90	0.80	0.88

Note: Estimates are for the May 2004 data vintage studied in Siklos and Weymark (2008), where further details about estimation procedures and results may be found.

Table 2

Ex Post Inflation Pressure Versus Actual Inflation:

Summary Statistics

Country	Range	Mean	Std. Dev.	Obs.
Australia	$[-0.04, -0.02)$	-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
Canada	$[-0.05, 0)$	-0.023293	0.020115	5
	[0,0.05)	0.056285	0.006914	2
	All	0.018583	0.019746	53
New Zealand	$[-0.06, -0.04)$	-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	-0.001856	0.013700	59
United States	$[-1, -0.05)$	-0.703223	0.104911	4
	$[-0.05, 0)$	-0.207034	0.155794	27
	[0,0.05)	0.157315	0.131356	33
	[0.5,1)	0.697228	0.233463	2
	All	-0.027530	0.307472	66

Table 3

Comparison of Changes in Inflation Expectations

Country	proportion of EAIP removed by changes in inflation expectations		percent of observations when inflation expectations changed independently of interest rates
	average	(std. dev.)	
Australia	0.8072	(0.9690)	14.25
Canada	1.0255	(0.1201)	74.05
New Zealand	1.0336	(0.2047)	56.34
United States	−2.5971	(21.6220)	0.90

Note: The proportion of EAIP removed by changes in inflation expectations is calculated as [1 - MPE]. Periods in which inflation expectations moved independently of interest rates are characterized by [1-MPE$_t$] $\neq 0$ and $\Delta i_t = 0$.

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Appendix 1

Inflation Pressure Indices

Our inflation pressure indices, EPIP and EAIP, are not directly observable and must be imputed on the basis of an appropriately specified structural model. The models we have used for Australia, Canada, and New Zealand are similar in that each model is composed of a Phillips Curve, an IS curve, an interest rate response function (i.e., Taylor Rule), and an asset arbitrage equation (UIP or modified UIP). However, we have allowed the details of these component equations to differ in order to obtain the best possible fit to each country's data set.

In this appendix, the model we use to characterize the Australian economy is used to illustrate the our method of obtaining ex post and ex ante inflation pressure measures. The following equations characterize the Australian economy:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2 \mathrm{E}_t\pi_{t+4} + \alpha_3\tilde{y}_{t-1} + \alpha_4[\pi_t - \Delta q_t - \pi{*}_t] + \epsilon_t \tag{A.1}$$

$$\tilde{y}_t = \beta_0 + \beta_1\tilde{y}_{t-1} - \beta_2[i_t - \mathrm{E}_t\pi_{t+1}] - \beta_3[\pi_t - \Delta q_t - \pi{*}_t] + \eta_t \tag{A.2}$$

$$i_t = i_t^* + \mathrm{E}_t q_{t+1} - q_t + \delta_o\Delta\pi_t + \delta_1\Delta i_t + \delta_2\Delta q_t + \delta_t \tag{A.3}$$

$$i_t = \rho_t i_{t-1} + (1-\rho_t)[\gamma_0 + \gamma_\pi \mathrm{E}_t\pi_{t+3} + \gamma_y \mathrm{E}_t\tilde{y}_{t+1} + \sigma_t] \tag{A.4}$$

A1.1 The EAIP Index

We define ex ante inflation pressure for period t as the change in the exchange rate that would have occurred in period t if economic agents had anticipated the policy authority's decision to refrain from intervention in that period. In order to calculate our counterfactual EAIP measure, we therefore need to be able to determine what would have happened to private agents' expectations about inflation, the exchange rate, and the output gap in this case. Consequently, the first step in deriving model-consistent EAIP measures, is to obtain the rational expectations solution for our model.

Even though our model is a relatively simple one, it is nevertheless too complex to allow closed-form rational expectations solutions to be obtained analytically; we use the computational algorithm developed by Sims (2001) to compute the RE solutions for the endogenous variables π_t, $\tilde{y}_t$ and q_t for each country in our sample. Details of the numerical compuation are available upon request.

According to our definition, EAIP is measured quarter by quarter which means that the calculation of EAIP for period t requires ρ to be set equal to 1 only in period t; in all other periods ρ should be set equal to the value associated with the policy actually implemented in that period. In order to derive counter-factual expectations which take into account this hypothetical, one-period deviation from the policy actually implemented, we compute a numerical RE solution for our model with ρ set equal to the sample average value.[1] The RE solutions obtained using the average observed value of ρ are then used to express expectations about future inflation, output gap, and exchange rate as functions of ρ_t and variables dated period t or earlier. The impact of the counterfactual policy on expectations may then be captured by setting $\rho_t = 1$.[2]

The RE solutions for the variables π_t, $\tilde{y}_t$, i_t, and q_t, are of the following general form:

$$\begin{aligned} x_t &= h_0^x + h_1^x \pi_{t-1} + h_2^x \tilde{y}_{t-1} + h_3^x q_{t-1} + h_4^x i_{t-1} + h_5^x q_{t-2} + h_6^x \pi_{t-1}^* + h_7^x i_{t-1}^* \\ &\quad + h_8^x \epsilon_t + h_9^x \eta_t + h_{10}^x \sigma_t + h_{11}^x \delta_t + h_{12}^x g_t + h_{13}^x e_t \qquad \text{(A.5)} \end{aligned}$$

where x is replaced by π, $\tilde{y}$, i, or q, to obtain the RE solution for each of these endogenous variables.

[1] In reality, ρ is time-varying. However, the numerical procedure we employ requires that ρ take on a constant value over time. Rather than calculate separate RE solutions for each quarter, we have chosen to use an average value for all quarters.

[2] We assume that economic agents are rational and fully informed. Consequently, the RE coefficients obtained under the counterfactual assumption $\rho_t = 1$ can be expected to differ from those associated with the policy rule that was actually implemented. A precise representation of the impact of such a deviation from the policy rule on expectations requires a closed-form RE solution. Because our model does not admit a tractable closed-form solution, we approximate the solution by employing the RE coefficients computed under the observed policy rule. Given that we are only failing to adjust the coefficients for a one-period deviation from the estimated policy rule, this approximation should not have any significant impact on the quantitative results obtained.

Table A1

Estimated Rational Expectations Solutions for Australia

π_t	const	π_{t-1}	$\tilde{y}_{t-1}$	q_{t-1}	i_{t-1}	q_{t-2}	π^*_{t-1}	i^*_{t-1}
	2.1400	0.3042	−0.7842	−0.0568	−0.0056	0.0004	0.1664	0.1353
	ϵ_t	η_t	σ_t	δ_t	g_t	e_t		
	0.3559	−1.0739	−0.0291	0.0215	0.1849	0.1504		
$\tilde{y}_t$	const	π_{t-1}	$\tilde{y}_{t-1}$	q_{t-1}	i_{t-1}	q_{t-2}	π^*_{t-1}	i^*_{t-1}
	−3.4509	0.9228	2.3060	0.0817	−0.0064	−0.0006	−0.2295	−0.1985
	ϵ_t	η_t	σ_t	δ_t	g_t	e_t		
	1.0697	2.6379	0.0276	−0.0323	−0.2550	−0.2206		
q_t	const	π_{t-1}	$\tilde{y}_{t-1}$	q_{t-1}	i_{t-1}	q_{t-2}	π^*_{t-1}	i^*_{t-1}
	91.8578	−23.3605	−40.2663	−1.1476	−0.1321	0.0147	5.1855	5.2014
	ϵ_t	η_t	σ_t	δ_t	g_t	e_t		
	-27.0824	−44.0010	−1.0051	0.8063	5.7616	5.7794		
i_t	const	π_{t-1}	$\tilde{y}_{t-1}$	i_{t-1}	i_{t-1}	q_{t-2}	π^*_{t-1}	i^*_{t-1}
	−7.6572	2.7684	5.6257	0.1558	0.7822	0.0006	−0.5215	−0.3521
	ϵ_t	η_t	σ_t	δ_t	g_t	e_t		
	3.2224	6.2851	0.8179	0.0328	−0.5795	−0.3912		

The next step in computing our counterfactual model-consistent EAIP formula is to use (A.5) and the estimated rational expectations coefficients given in to obtain expressions for the expectational variables that appear in (A.1)–(A.3). Note that because EAIP will be computed under the constraint $\rho_t = 1$, we will not need to obtain expressions for the expectational variables in (A.4) unless they are required in one of the other three equations. The critical expectations in the case of our Australian model are: $\mathrm{E}_t\pi_{t+1}$, $\mathrm{E}_t\pi_{t+4}$, and $\mathrm{E}_t q_{t+1}$. In order to impose the constraint $\rho_t = 1$ we need to express each of these expectations in terms of variables dated t or earlier. Because our computational solution is the minimal state variable solution, no further manipulation of the one-period-ahead forecasts of inflation and the nominal exchange rate is needed in order to satisfy this requirement. This is not the case for $\mathrm{E}_t\pi_{t+4}$ where we apply a succession of backward substitutions to achieve the desired representation. After substituting our final expectations expressions back into (A.1)–(A.3) and imposing the constraint $\rho_t = 1$ we obtain the following matrix representation of the Australian economy:

$$\begin{bmatrix} 0.9620 & -0.0446 & -0.0271 \\ -0.0448 & 1.0116 & 0.0411 \\ 23.4469 & 40.2663 & 2.1658 \end{bmatrix} \begin{bmatrix} \pi_t^0 \\ \tilde{y}_t^0 \\ q_t^0 \end{bmatrix} = \begin{bmatrix} X_t^{\pi^0} \\ X_t^{y^0} \\ X_t^{q^0} \end{bmatrix} \tag{A.6}$$

where

$$\begin{aligned} X_t^{\pi^0} &= -\,0.1065 + 0.8600\pi_{t-1} + 0.1950\tilde{y}_{t-1} - 0.0280q_{t-1} + 0.0011i_{t-1} \\ &\quad + 0.1262\pi_t^* + 0.0036i_t^* + \epsilon_t \\[1em] X_t^{y^0} &= 0.0783 + 0.7951\tilde{y}_{t-1} + 0.0403q_{t-1} - 0.0149i_{t-1} - 0.0378\pi_t^* \\ &\quad + 0.0020i_t^* + \eta_t \\[1em] X_t^{q^0} &= 91.8578 - 0.0864\pi_{t-1} + 0.0329q_{t-1} - 1.1321i_{t-1} + 5.1855\pi_t^* \\ &\quad + 5.2014i_t^* + \delta_t \end{aligned}$$

Note that the 0 superscript on the variables in (A.6) indicates that the values given in the matrix were obtained under the constraint $\rho = 1$ (i.e, under the counterfactual assumption $\Delta i_t = 0$). Solving (A.6) for π_t^0 yields the model-consistent formula for Australia's ex ante inflation rate:

$$\pi_t^0 = 1.9042 + 0.3984\pi_{t-1} + 0.0889\tilde{y}_{t-1} + 0.0487q_{t-1} - 0.0116i_{t-1} + 0.2052\pi_t^* + 0.1144i_t^* + 0.4655\epsilon_t - 0.8574\eta_t + 0.0220\delta_t. \quad \text{(A.7)}$$

By definition, $\text{EAIP}_t = \pi_t^0 - \pi_{t-1}$, so, for Australia, our model-consistent EAIP formula is:

$$\text{EAIP}_t = 1.9042 - 0.6016\pi_{t-1} + 0.0889\tilde{y}_{t-1} + 0.0487q_{t-1} - 0.0116i_{t-1} + 0.2052\pi_t^* + 0.1144i_t^* + 0.4655\epsilon_t - 0.8574\eta_t + 0.0220\delta_t. \quad \text{(A.8)}$$

A1.2 The EPIP Index

Ex post inflation pressure is the amount of inflation pressure that remains after the intervention policy has been implemented. When a policy authority implements an interest rate policy, the interest rate change alleviates inflation pressure to some degree. Consequently, observed inflation changes will reflect the total amount of inflation pressure present in the economy only in the absence of such an interest rate change. Whenever this is not the case and $\rho \neq 1$, the magnitude of EPIP will have to be imputed from observed changes in the inflation rate as well as observed interest rate changes. Because inflation and interest rate changes are not likely to be commensurate in their economic impact, the computation of EPIP involves a measurement experiment in which observed interest rate changes are converted into inflation equivalent units and then combined with observed changes in inflation to yield a composite summary statistic. In this section we describe the method by which model-consistent EPIP indices can be obtained.

We begin by substituting (A.3) into (A.4) to eliminate i_t. Using the resulting equation, together with (A.1) and (A.2), the Australian economy can be characterized, in matrix form, as:

$$\begin{bmatrix} (1-\alpha_4) & 0 & \alpha_4 \\ \beta_3 & 1 & -\beta_3 \\ \delta_0 & 0 & (\delta_2 - 1) \end{bmatrix} \begin{bmatrix} \pi_t \\ \tilde{y}_t \\ q_t \end{bmatrix} = \begin{bmatrix} Z_t^\pi \\ Z_t^y \\ Z_t^q \end{bmatrix} \quad \text{(A.9)}$$

where

$$\begin{aligned}
Z_t^{\pi} &= \alpha_0 \;+\; \alpha_1\pi_{t-1} \;+\; \alpha_2 \mathrm{E}_t\pi_{t+4} \;+\; \alpha_3\tilde{y}_{t-1} \;+\alpha_4 q_{t-1} \;-\; \alpha_4\pi_t^* \;+\; \epsilon_t \\
Z_t^{y} &= \beta_0 \;+\; \beta_1\tilde{y}_{t-1} \;-\; \beta_2\rho_t i_{t-1} \;-\beta_2(1-\rho_t)\{\gamma_0+\gamma_\pi \mathrm{E}_t\pi_{t+3}+\gamma_y \mathrm{E}_t\tilde{y}_{t+1}+\sigma_t\} \\
&\quad +\; \beta_2 \mathrm{E}_t\pi_{t+1} \;-\; \beta_3 q_{t-1} \;+\; \beta_3\pi_t^* \;+\; \eta_t \\
Z_t^{q} &= -i_t^* \;-\; \mathrm{E}_t q_{t+1} \;+\; \delta_0\pi_{t-1} \;-\; \delta_1 i_{t-1} \;+\; \delta_2 q_{t-1} \;+\; (1-\delta_1)\rho_t i_{t-1} \\
&\qquad +\; (1-\delta_1)(1-\rho_t)[\gamma_0+\gamma_\pi \mathrm{E}_t\pi_{t+3}+\gamma_y \mathrm{E}_t\tilde{y}_{t+1}+\sigma_t] \;-\; \delta_t.
\end{aligned}$$

The semi-reduced form for the observed inflation rate, which is obtained by solving $(A.9)$ for π_t, is given by

$$\pi_t \;=\; H^{-1}\{Z^{\pi} \;+\; \alpha_4 Z^q\} \tag{A.10}$$

where $H = (1-\alpha_4)(\delta_2-1)-\alpha_4\delta_0$.

In order to compute the ex post inflation rate, we conduct a measurement experiment in which we set ρ equal to 1 in $(A.9)$ but do not allow this hypothetical change in intervention activity to have any impact on expectations. Solving the resulting system for π_t, we obtain the following expression for the ex post inflation rate π_t^{xp}

$$\pi_t^{xp} \;=\; \pi_t \;+\; \frac{(1-\rho_t)\alpha_4(1-\delta_1)}{H}\{-i_{t-1} \;+\; \gamma_0+\gamma_\pi \mathrm{E}_t\pi_{t+3}+\gamma_y \mathrm{E}_t\tilde{y}_{t+1}+\sigma_t\}. \tag{A.11}$$

From $(A.4)$ we know that $(1-\rho_t)\{\gamma_0+\gamma_\pi \mathrm{E}_t\pi_{t+3}+\gamma_y \mathrm{E}_t\tilde{y}_{t+1}+\sigma_t\} = i_t-\rho_t i_{t-1}$. Consequently, we obtain the following operational, model-consistent π_t^{xp} formula for Australia:

$$\pi_t^{xp} \;=\; \pi_t \;-\; \frac{\alpha_4(1-\delta_1)}{(1-\alpha_4)(\delta_2-1)-\alpha_4\delta_0}\Delta i_t. \tag{A.12}$$

We define ex post inflation pressure in period t, $EPIP_t$, as

$$EPIP_t \;=\; \pi_t^{xp}-\pi_{t-1}. \tag{A.13}$$

The operational, model-consistent $EPIP$ formula for Australia is therefore given by

$$EPIP_t \;=\; \Delta\pi_t \;-\; \frac{\alpha_4(1-\delta_1)}{(1-\alpha_4)(\delta_2-1)-\alpha_4\delta_0}\Delta i_t. \tag{A.14}$$

Appendix 2

Inflation Pressure Estimates

Table A2.1

Ex Post and Ex Ante Inflation Pressure Estimates:

Australia 1985:1 – 2003:3

	actual	ex post	ex ante		actual	ex post	ex ante
1985:1	4.2549	4.3208	5.0089	1995:1	3.8223	3.8545	5.5204
2	6.4440	6.5264	4.3425	2	4.4050	4.4055	5.6116
3	7.3235	7.3358	4.3114	3	4.9691	4.9690	5.3124
4	7.9160	7.9648	4.9790	4	4.9305	4.9303	5.4309
1986:1	8.8173	8.8367	5.2684	1996:1	3.6815	3.6818	4.4594
2	8.0949	7.9802	6.4594	2	3.0470	3.0469	4.8747
3	8.5088	8.5669	6.1522	3	2.1067	2.0978	4.3018
4	9.3334	9.3448	6.4290	4	1.5056	1.4898	4.2384
1987:1	9.0214	9.0200	6.4695	1997:1	1.2545	1.2391	4.3826
2	8.8807	8.8159	6.4984	2	0.3317	0.3266	2.9807
3	7.9635	7.9151	5.9622	3	−0.4327	−0.3620	3.0654
4	6.8231	6.7908	4.6331	4	−0.2458	−0.2493	2.4595
1988:1	6.6350	6.6239	4.9205	1998:1	−0.1706	−0.1709	2.0969
2	6.8154	6.8384	5.1332	2	0.6708	0.6714	2.2859
3	7.0347	7.0683	5.6199	3	1.3320	1.3315	1.9814
4	7.4108	7.4517	5.2995	4	1.5712	1.5693	1.4012
1989:1	6.5958	6.6372	4.9599	1999:1	1.2411	1.2355	1.6767
2	7.3289	7.3672	4.2686	2	1.0660	1.0667	1.7896
3	7.6993	7.7066	3.7536	3	1.7211	1.7208	2.6835
4	7.4695	7.5158	4.4803	4	1.7851	1.7894	2.3551
1990:1	8.2187	8.1944	4.2600	2000:1	2.7553	2.7665	3.2276
2	7.3809	7.3311	4.4060	2	3.1417	3.1578	3.0224
3	5.9010	5.8819	5.2853	3	5.8989	5.9058	5.1173
4	6.6228	6.5858	5.7927	4	5.6422	5.6442	6.1817
1991:1	4.7468	4.7174	5.3596	2001:1	5.8166	5.8070	6.0129
2	3.3505	3.3254	5.5840	2	5.8486	5.8252	5.8561
3	3.1446	3.1216	5.8462	3	2.4896	2.4869	3.7314
4	1.5029	1.4681	5.5406	4	3.0718	3.0585	3.6127
1992:1	1.6848	1.6494	5.4850	2002:1	2.8990	2.8940	3.6705
2	1.2280	1.2086	5.6836	2	2.8008	2.8071	3.4547
3	0.7440	0.7132	4.8812	3	3.1548	3.1625	3.6830
4	0.2741	0.2731	4.0881	4	2.9895	2.9895	4.4536
1993:1	1.1980	1.1974	4.1555	2003:1	3.3823	3.3823	4.6356
2	1.8377	1.8259	4.7968	2	2.6518	2.6518	4.7206
3	2.2111	2.2017	5.7349	3	2.5626	2.5626	4.3420
4	1.9329	1.9287	4.5597				
1994:1	1.3701	1.3702	3.6822				
2	1.7238	1.7229	3.7772				
3	1.8997	1.9093	3.7473				
4	2.5128	2.5474	4.6937				

TABLE A2.2.1

Ex Post and Ex Ante Inflation Pressure Estimates:

Canada 1978:4 – 1998:4

	actual	ex post	ex ante		actual	ex post	ex ante
1978:4	8.3074	8.3169	23.6996				
1979:1	8.7079	8.6229	25.1093	1989:1	4.3932	4.3869	20.2633
2	8.8787	8.9264	27.4770	2	4.8444	4.8267	21.1770
3	8.3474	8.3730	24.4178	3	5.1679	5.1862	20.8931
4	9.0418	8.9826	28.8221	4	5.0741	5.0900	20.4968
1980:1	9.0165	9.0725	30.4037	1990:1	5.2694	5.2597	21.6599
2	9.1558	9.0179	29.1919	2	4.4532	4.4626	18.8762
3	10.0031	10.2067	29.2286	3	4.1129	4.1291	17.9020
4	10.5476	10.4309	29.0832	4	4.8011	4.8434	17.8814
1981:1	11.5505	11.5045	32.3365	1991:1	6.2372	6.2940	16.7197
2	11.8638	11.8761	32.5162	2	6.0752	6.1249	16.2611
3	11.9658	11.8895	31.6229	3	5.5383	5.5619	14.8118
4	11.6034	11.7180	29.4790	4	4.0275	4.0694	12.5243
1982:1	10.9023	10.9854	24.7266	1992:1	1.6100	1.6402	8.5725
2	10.8791	10.8699	21.5625	2	1.3633	1.3982	8.2242
3	10.0761	10.0741	17.9875	3	1.2275	1.2546	7.9264
4	9.2328	9.3480	14.0170	4	1.7760	1.7443	8.2270
1983:1	7.3790	7.4372	12.2417	1993:1	2.0486	2.1098	9.1126
2	5.7337	5.7686	12.3741	2	1.7334	1.7815	8.7162
3	5.1736	5.1907	11.7636	3	1.7300	1.7485	8.5226
4	4.4175	4.4334	11.9784	4	1.7931	1.8115	8.9694
1984:1	4.9811	4.9867	15.0619	1994:1	0.5623	0.5807	8.2370
2	4.4838	4.4830	15.2132	2	0.0261	−0.0052	8.3859
3	3.8438	3.8096	13.3604	3	0.1484	0.1756	10.0398
4	3.7134	3.7411	14.6857	4	0.0000	0.0139	9.8619
1985:1	3.6231	3.6796	14.8271	1995:1	1.5476	1.4994	12.2350
2	3.8765	3.8894	13.9984	2	2.6769	2.6933	12.9135
3	3.9026	3.9480	14.4902	3	2.3302	2.3774	11.1639
4	4.0845	4.0858	15.5278	4	2.0297	2.0549	10.4746
1986:1	4.1773	4.1194	13.0397	1996:1	1.4412	1.4747	8.8327
2	3.8245	3.9311	11.6341	2	1.4266	1.4529	8.2447
3	4.1278	4.1536	10.9244	3	1.3954	1.4240	8.6450
4	4.2205	4.2325	8.8101	4	1.9893	2.0307	9.8387
1987:1	3.9436	3.9769	11.2422	1997:1	2.0724	2.0911	10.0047
2	4.5592	4.5658	14.0923	2	1.6250	1.6392	8.9318
3	4.4401	4.4314	15.6403	3	1.7137	1.7216	9.4949
4	4.1412	4.1729	16.2224	4	1.0239	1.0241	8.0271
1988:1	4.0168	4.0208	17.0072	1998:1	1.0186	1.0139	7.9969
2	3.8952	3.9050	17.8694	2	0.9945	1.0044	7.0424
3	3.8884	3.8812	17.7292	3	0.8321	0.8379	6.4205
4	3.9809	3.9764	18.4059	4	1.0831	1.0970	7.1179

TABLE A2.2.2

Ex Post and Ex Ante Inflation Pressure Estimates:

Canada 1999:1 – 2004:2

	actual	ex post	ex ante		actual	ex post	ex ante
1999:1	0.7624	0.7795	7.5987	2002:1	1.5229	1.5512	7.7825
2	1.5455	1.5687	9.5383	2	1.3291	1.3349	7.6787
3	2.1833	2.1991	11.3151	3	2.3014	2.3055	9.6529
4	2.3253	2.3370	12.5402	4	3.7155	3.7300	11.7017
2000:1	2.6555	2.6628	14.0762	2003:1	4.3755	4.3878	12.9685
2	2.4470	2.4464	13.9952	2	2.7708	2.7748	9.5260
3	2.6919	2.7025	14.7589	3	2.0922	2.1151	8.9151
4	3.0329	3.0467	14.1602	4	1.6962	1.7149	8.8306
2001:1	2.7315	2.7573	12.8489	2004:1	0.8698	0.8928	8.0599
2	3.5359	3.5681	13.0018	2	2.1603	2.1854	12.1063
3	2.6536	2.6852	9.7058				
4	1.1006	1.1520	7.0207				

Table A2.3

Ex Post and Ex Ante Inflation Pressure Estimates:

New Zealand 1990:1 – 2004:3

	actual	ex post	ex ante		actual	ex post	ex ante
1990:1	7.1774	7.1807	15.7565	1998:1	1.7392	1.7592	3.3757
2	7.6866	7.6834	16.2557	2	1.6327	1.6359	2.8162
3	4.8494	4.8603	13.2259	3	1.7233	1.6820	2.8525
4	4.5517	4.5372	11.8327	4	1.1128	1.0753	2.3828
1991:1	4.3976	4.3786	12.2115	1999:1	1.0091	1.0071	2.0799
2	2.9397	2.9207	9.8931	2	1.2073	1.2215	2.5011
3	2.8006	2.7850	8.3066	3	0.9005	0.9003	2.9419
4	2.0858	2.0633	6.4261	4	1.2994	1.3029	3.5007
1992:1	2.0714	2.0595	4.8715	2000:1	1.6924	1.7009	4.1616
2	2.1777	2.1707	4.7743	2	1.9803	1.9938	5.3468
3	2.0502	2.0414	4.9549	3	3.0409	3.0457	6.1097
4	2.1555	2.1589	4.8977	4	3.7998	3.7998	7.3181
1993:1	1.6940	1.7219	4.4318	2001:1	3.1101	3.1093	7.4598
2	1.6864	1.6579	4.3083	2	3.2790	3.2710	7.1046
3	1.7878	1.7693	4.5597	3	2.3867	2.3832	6.2953
4	1.5591	1.5610	4.1269	4	1.8940	1.8834	4.5731
1994:1	1.5556	1.5492	4.0197	2002:1	2.5509	2.5478	4.1310
2	1.5487	1.5624	3.8608	2	2.7143	2.7227	3.9073
3	1.8651	1.8724	3.8628	3	2.6072	2.6135	3.8293
4	2.2939	2.3156	5.0395	4	2.7754	2.7755	4.3580
1995:1	2.5042	2.5212	5.3936	2003:1	2.5784	2.5784	5.1390
2	2.7073	2.7105	6.0379	2	1.4666	1.4627	4.8502
3	2.0442	2.0467	5.8431	3	1.4599	1.4533	3.5221
4	2.0311	2.0241	4.9963	4	1.4493	1.4483	3.6588
1996:1	2.1277	1.1295	5.1284	2004:1	1.5336	1.5363	3.5241
2	2.3232	2.3337	5.2923	2	2.3382	2.3429	4.0319
3	2.3159	2.3223	5.6570	3	2.5046	2.5122	5.9694
4	2.3014	2.2917	5.8106				
1997:1	1.9803	1.9526	5.8851				
2	1.4508	1.4407	4.8708				
3	1.7535	1.7705	4.0759				
4	1.6411	1.6327	3.8019				

Table A2.4

Ex Post and Ex Ante Inflation Pressure Estimates:

United States 1985:1 – 2004:1

	actual	ex post	ex ante		actual	ex post	ex ante
1985:1	3.5764	−0.5093	0.1937	1995:1	3.8007	0.2365	0.8499
2	3.5436	−0.0335	0.6334	2	3.0484	0.2415	0.8787
3	3.2975	−0.2404	0.4054	3	2.6291	−0.4214	0.2050
4	3.4534	0.1483	0.8200	4	2.5924	−0.0466	0.5926
1986:1	3.0582	−0.4204	0.2839	1996:1	2.7459	0.1501	0.7667
2	1.6647	−1.4133	−0.7257	2	2.7879	0.0438	0.6475
3	1.6544	−0.0085	0.6257	3	2.8589	0.0703	0.6803
4	1.3366	−0.3192	0.2936	4	3.1803	0.3213	0.9365
1987:1	2.0178	0.6932	1.2799	1997:1	2.9024	−0.2710	0.3309
2	3.6324	1.6199	2.2139	2	2.2757	−0.6265	−0.0033
3	4.0786	0.4482	1.0590	3	2.2007	−0.0758	0.5435
4	4.3113	0.2257	0.8820	4	1.8731	−0.3272	0.2843
1988:1	3.8888	−0.4088	0.2129	1998:1	1.4717	−0.4020	0.2123
2	3.9028	0.0369	0.6552	2	1.5709	0.1002	0.7047
3	4.0589	0.1696	0.8021	3	1.5836	0.1002	0.7047
4	4.2162	0.1844	0.7983	4	1.5143	−0.0728	0.5297
1989:1	4.5685	0.3602	1.0191	1999:1	1.6732	0.1593	0.7556
2	5.0315	0.4451	1.1636	2	2.0904	0.4268	1.0094
3	4.5985	−0.4460	0.2668	3	2.3194	0.2349	0.8293
4	4.5235	−0.0851	0.6259	4	2.5861	0.2770	0.8708
1990:1	5.1006	0.5769	1.2598	2000:1	3.1863	0.6167	1.2079
2	4.4815	−0.6214	0.0613	2	3.2407	0.0613	0.6878
3	5.4152	0.9221	1.6369	3	3.4101	0.1680	0.8181
4	6.0874	0.6357	1.3834	4	3.3855	−0.0490	0.6534
1991:1	5.1254	−0.9776	−0.2700	2001:1	3.3346	−0.0861	0.6267
2	4.7328	−0.3987	0.2862	2	3.3273	−0.0304	0.6484
3	3.7797	−0.9761	−0.2848	3	2.6618	−0.7033	−0.0092
4	2.9222	−0.8794	−0.2016	4	1.8200	−0.8529	−0.2278
1992:1	2.8528	−0.0765	0.5508	2002:1	1.2247	−0.5948	−0.0141
2	3.0272	0.1602	0.7891	2	1.2894	0.0644	0.6322
3	3.0283	−0.0050	0.6031	3	1.6006	0.3030	0.8811
4	3.0742	0.0460	0.6464	4	2.2110	0.6050	1.1753
1993:1	3.1238	0.0484	0.6544	2003:1	2.8431	0.6320	1.1977
2	3.0772	−0.0449	0.5598	2	2.1309	−0.7186	−0.1339
3	2.7783	−0.3008	0.3072	3	2.1553	0.0239	0.6047
4	2.7217	−0.0404	0.5487	4	1.8570	−0.2982	0.2708
1994:1	2.5079	−0.2036	0.3534	2004:1	1.7859	−0.0709	0.5100
2	2.3547	−0.1381	0.4379				
3	2.8152	0.4794	1.0507				
4	2.5700	−0.2273	0.3525				