DOES TALK MATTER AFTER ALL?

INFLATION TARGETING AND CENTRAL BANK BEHAVIOR

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Abstract

Interpretations of inflation targeting (IT) have ranged widely, from "inflation-only targeting" without regard for output, to cheap talk without effect, to transparency increasing flexibility without cost. We characterize five interpretations of the adoption of IT as shifts between strategies in a conventional model of monetary time-inconsistency. Their implications for central bank behavior are compared to the time-series properties of inflation, and the response of interest rates to inflation movements, for three countries adopting IT in the early 1990s.

There is no evidence that IT entails a single-minded pursuit of the inflation target. For the U.K. and Canada, lower inflation levels and persistence post-adoption are combined with greater accommodation of real shocks and more stable private-sector inflation expectations. This is consistent with successful approximation of the optimal state-contingent rule. The results for New Zealand post adoption mix reduced inflation level and persistence with less stable inflation expectations, perhaps reflecting increased rule-like conservatism.

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Since 1990, a number of economies — including Australia, Brazil, Canada, Chile, Finland, Israel, New Zealand, Spain, Sweden, and the United Kingdom — have adopted inflation targeting as their declared monetary strategy, and the European System of Central Banks is relying on it as part of a hybrid approach.[1] Yet, to many observers, it is not entirely clear how inflation targeting in practice serves the purpose asserted for it in theory. If inflation targeting simply consists of the central bank (or the controlling government) announcing its inflation goal — the π^* in the familiar rules-versus-discretion models following Kydland and Prescott (1977) and Barro and Gordon (1983) — it either is providing the private sector with information already presumed to be known in these models, or it is making a less than credible claim (in the sense of actions not talk defining weak versus strong types as in Cukierman and Meltzer [1986]). If inflation targeting is instead a commitment that the central bank will target inflation with too little regard for other goals — the characterization given in Friedman and Kuttner (1996) and in various countries' political

[1] Contemporaneous with this development, an academic literature on inflation targeting has arisen, led by the contributions of Svensson (1997a, 1997b, Svensson and Faust 1998). Other works include Ball (1998, 1999), Bernanke and Mishkin (1996), Bernanke and Woodford (1997), Haldane, ed. (1995), and Leiderman and Svensson, eds. (1995).

discussions — it is merely a limiting-case for the Rogoffian (1985) conservative central banker rather than a new type of monetary strategy, let alone a welfare-improving one.

The matching of model and operational practice is made more complicated by the institutional patterns which have emerged amongst inflation targeting central banks. As described in Mishkin and Posen (1997) and in Bernanke, et al. (1999), a largely consistent operational form has been adopted by all inflation targeting central banks implying a convergence on best practice. This operational form does begin with the public declaration of a numerical goal for inflation over a specified time-frame, but it does not end there. It also always includes a number of other elements, notably regular publication of an *Inflation Report*-type document, explaining the sources of inflationary pressures in the economy, as well as careful design and detailed public description of the target inflation series and range. Moreover, every inflation targeting central bank exhibits flexibility in response to economic shocks (whether or not granted formal "escape clauses") and gradualism in the pursuit of their inflation goals (see the case studies in Bernanke, et al. [1999] for details).

What, then, actually is inflation targeting? Does the central bank talk and institutional aspects associated with it serve a purpose, or is it solely verbal window dressing? If inflation targeting is instead merely a shift in preferences, can this be consistent with the apparently measured rather than crusading pursuit of low inflation by inflation targeting central banks? This paper distinguishes five different possible interpretations of inflation targeting consistent with various strands present in the current literature. The existence of so many viable interpretations of inflation targeting may indicate that current academic discussions — and

policy regimes — have taken the effects of this new monetary regime on central bank behavior for granted.[2]

Part 1 builds on the simple models of King (1997) and Svensson (1997a), to derive the implications for central bank behavior and inflation expectations of three different types of central bankers (untrusted discretionary, strictly conservative, trusted OSCR-following). Part 2 maps five different characterizations of inflation targeting onto shifts between specific pairs of these types of central bankers. Part 3 examines the hypothesized shifts in central bank behavior associated with each shift (and interpretation) empirically, in terms of both the time-series behavior of inflation, and the impact of inflation surprises on long and short interest rates after adoption. Our results show that the adoption of inflation targeting in the United Kingdom, Canada, and, to a lesser degree, New Zealand, was associated with a reduction in both the level and persistence of inflation without an increase in the relative weight on inflation versus real goals. In the United Kingdom and Canada, accommodation of the real effects of inflationary shocks increased after adoption at the same time that long-run inflation expectations became more stable. Part 4 concludes that such a combination of results is consistent with the adoption of inflation targeting being a shift from discretionary or conservative central banking towards the optimal state contingent rule, and therefore may be characterized as a form of trust building by talking.

[2] While there is a growing empirical literature on inflation targeting, most studies, such as Ammer and Freeman (1995), Laubach and Posen (1997a), and Johnson (1997) have examined inflation outcomes. Almeida and Goodhart (1997) is one study that explicitly considers central bank behavior.

1. A Modelling Framework for Inflation Targeting

An oft-voiced concern about inflation targets is that they prevent central banks from responding flexibly to macroeconomic shocks. Central banks operating under unchecked discretion, on the other hand, may lack the discipline to rein in the effects of inflationary shocks, resulting in "inflation scares." This section sketches a simple model to formalize these impressions, and characterize central bank behavior under alternative policy regimes: discretionary, conservative, and the "optimal state-contingent rule."

The model itself is based on Svensson (1997a) and Lockwood et al. (1995), which, in turn, draw on the Barro-Gordon (1983) framework. Our contribution is to append aggregate demand and term structure equations, allowing us to describe the response of interest rates under the various regimes. We show that under discretion, the response of short-term interest rates to supply shocks is mild, but volatile inflation expectations lead to a sharp response of long-term interest rates. Imposing more conservative preferences on the central bank — one interpretation of inflation targeting — naturally leads to a more vigorous anti-inflationary policy response. A rule in which the central bank commits to a target average inflation rate, however, allows it to respond flexibly to short-term disturbances. In this case — King's (1997) "optimal state contingent rule" — the response of policy is mild, but the reaction of long-term rates is muted.

The problem of the central bank (CB) is essentially to stabilize output and inflation around their targets. Formally, the central bank is assumed to minimize the discounted sum of single-period loss functions of the form:

$$L_t = \pi_t^2 + \lambda (y_t - y^*)^2 \ ,$$

where π is the inflation rate and y is the gap between output and potential. For convenience, we assume the target rate of inflation is zero, and we follow convention in assuming the desired output gap y^* is greater than zero; neither assumption is essential. The λ parameter represents the CB's weight on output stabilization vis à vis inflation, and this parameter is known to the public.[3]

Output obeys a Lucas-style aggregate supply relation,

$$y_t = \rho y_{t-1} + \alpha(\pi_t - \pi_t^e) + \epsilon_t \ ,$$

in which higher-than-expected inflation generates an increase in output, giving the CB an incentive to mislead the public. Consequently, as Barro and Gordon (1983) showed, promises of low inflation are typically not time consistent absent a commitment or punishment mechanism. The ϵ shock is interpreted as a supply-side disturbance, and persistence is introduced through the autoregressive term, ρy_{t-1}.

Following convention, we assume that private-sector inflation expectations are formed rationally before the ϵ disturbance is realized, so that $\pi_t^e = E_{t-1}\pi_t$. The CB *can* observe ϵ in real time, however, and sets policy contingent on its realization. This key assumption means the CB can play a constructive role in stabilization: when there is an adverse disturbance (a negative ϵ realization), the CB's optimal policy is to partially offset its effects on output by generating surprise inflation.

Under discretion, when the CB is free to re-optimize each period, optimal policy in this model is described by a decision rule of the form

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[3] Interesting complications are introduced when the CB's preferences are unknown, but must be inferred by the public. Examples include Backus and Driffill (1985), Garfinkel and Oh (1995), Faust and Svensson (1998).

$$\pi_t = a - b\epsilon_t - cy_{t-1} \ .$$

The *a* coefficient, representing the time-invariant inflation bias, depends on the model's parameters just as it does in the static models of Barro-Gordon (1983) and King (1997), i.e., increasing in y^* and λ. The $-b\epsilon_t$ term represents the CB's optimal response to the supply shock; the CB will partially offset an adverse shock by increasing inflation. The degree of accommodation, naturally, will be greater for larger values of λ.[4]

The key observation is that with persistence, discretion introduces a "state-contingent" inflation bias, represented by the $-cy_{t-1}$ term in the decision rule. When output is lower, the marginal contribution of the output deviation to the loss function is larger, increasing the temptation for the CB to inflate. The private sector understands this, of course, and expects higher inflation. In the end, inflation will be higher, but output will remain unaffected by policy.[5] It is the CB's futile effort to stabilize output that introduces persistence into the inflation process.

The behavior of a "conservative" central banker is similar, except the λ in the loss function is replaced with a smaller λ'. As in Rogoff (1985), such a policymaker will respond less to supply disturbances (smaller *b*), while delivering a lower average rate of inflation (smaller *a*) and reducing the state-contingent inflation bias (smaller *c*). The limiting case of

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[4] Since policy surprises affect future output as well, a larger ρ increases *a* and *b* for any given λ. Further details, and a derivation of the policy rule, appear in Svensson (1997a).

[5] A feature of Svensson's model is that over some range, expectations of future inflation fall as the weight assigned to output fluctuations increases. In the limiting case as $\lambda \to \infty$, an adverse supply shock has *no* effect on expected inflation. In that case, the inflation increase is sufficient to perfectly stabilize output, and with output constant, there is no change in the state-contingent inflation bias. This result would not hold in a model characterized by persistence in the inflation process.

the conservative central banker is the "inflation nutter," with $\lambda' = 0$. In this case, inflation is always zero ($a = c = 0$) and the CB makes no attempt to cushion the effects of supply shocks ($b = 0$). Inflation is stabilized, but at the expense of greater output volatility. Under both conservatism and pure discretion, therefore, policy faces a tradeoff between average inflation and flexibility in its response to shocks.

This tradeoff could be avoided if there were some mechanism, such as an inflation target, which would allow the CB to offset shocks while committing to hit its target inflation rate on average — King's (1997) "Optimal State Contingent Rule" (OSCR). As in Lockwood et al. (1995) and Svensson (1997a), the optimal decision rule in this case is:

$$\pi_t = -b^* \epsilon_t \ .$$

Like the discretionary CB, a policymaker following the OSCR will use temporarily higher inflation to cushion the effect of an adverse supply shock. For the same set of parameter values, however, the degree of accommodation will be somewhat less (i.e., $b^* < b$).[6] More importantly, both the time-invariant and state-contingent inflation biases disappear under the OSCR. The reason for this follows directly from the structure of the model: because only "surprise" policy actions affect output, it doesn't pay to respond to the predictable future output fluctuations caused by the shock. Under the OSCR, therefore, expected future inflation is zero ($E_t\pi_{t+1} = 0$), and any inflation fluctuations will be transitory.

Central banks of whatever type do not set the inflation rate directly, however; instead, they typically use a short-term interest rate to influence aggregate demand. A simple

[6] With output persistence, the discretionary CB sets policy in an attempt to affect future output as well, resulting in what Svensson (1997a) refers to as "stabilization bias."

extension of the model allows us to model monetary policy more realistically, and say something about the response of interest rates under alternative regimes. Aggregate demand is assumed to depend on the *ex ante* short-term (one-period) real interest rate,

$$y_t = \delta(i_{1,t} - E_t\pi_{t+1} - r^*) \ ,$$

where $\delta < 0$, and r^* is the real rate consistent with a zero output gap. Conditional on period t expectations of period $t+1$ inflation, the CB chooses the nominal short-term interest rate $i_{1,t}$ consistent with the real rate that will yield the desired combination of output and inflation.[7] Under the pure expectations hypothesis, the long-term (two-period) interest rate is just the average of current and expected future short-term interest rates,

$$i_{2,t} = \tfrac{1}{2}(i_{1,t} + E_t i_{1,t+1}) \ .$$

Thus, long-term rates not only contain information about current policy, but about inflation expectations as well.

Under discretion, the short-term interest rate that equates aggregate demand with aggregate supply is given by:

$$i_{1,t} = r^* + a + \delta^{-1}[(1-c)\rho y_{t-1} + (1 - \alpha b + c\alpha b)\epsilon_t] \ ,$$

and the long-term rate by:

$$i_{2,t} = r^* + a + \tfrac{1}{2}(\delta^{-1} - c)(1+\rho)[\rho y_{t-1} + (1 - \alpha b)\epsilon_t] \ .$$

Both interest rates contain a constant inflation premium (a) and terms involving lagged y reflecting the "state-contingent" inflation premium. Our focus, however, is on the policy

[7] This is tantamount to choosing π_t, of course, but this additional layer allows us to analyze the behavior of interest rates.

response to supply shocks, represented by the coefficient on ϵ. With $\delta < 0$, the CB raises interest rates to restrict aggregate demand when there is an adverse supply shock.

A conservative central bank, whose smaller λ' implies a smaller *b*, will sacrifice output for inflation stability by raising the short-term interest rate more sharply than the discretionary CB. Increased conservatism has two conflicting effects on the behavior of long-term interest rates. The conservative CB's less accommodative policy response (smaller *b*) translates into higher two-period interest rates. But at the same time, the smaller state-contingent inflation bias (smaller *c*) reduces the inflation premium in the two-period rate. The net effect is ambiguous.

In the limiting case of the "inflation nutter," there is no accommodation of the supply shock, and the short-term rate is raised to the point where its full effect is on output,

$$i_{1,t} = r^* + \delta^{-1}[\rho y_{t-1} + \epsilon_t] \ .$$

The long-term rate also rises sharply,

$$i_{2,t} = r^* + \tfrac{1}{2}\delta^{-1}(1+\rho)(\rho y_{t-1} + \epsilon_t) \ ,$$

but the inflation premium is absent. Again, the effect of supply shocks on long-term rates may be larger or smaller than under discretion, depending on the relative size of the initial policy response and the inflation premium.

Under the OSCR, the responses in short- and long-term interest rates are:

$$i_{1,t} = r^* + \delta^{-1}[\rho y_{t-1} + (1 - \alpha b^*)\epsilon_t] \ ,$$

and

$$i_{2,t} = r^* + \tfrac{1}{2}\delta^{-1}(1+\rho)[\rho y_{t-1} + (1-\alpha b^*)\epsilon_t] \ .$$

Because the CB is somewhat less accommodative than under discretion, short-term rates will respond somewhat more to supply shocks — although probably less than in the conservative or "inflation nutter" cases. But with $E_t\pi_{t+1} = 0$, the inflation premium disappears from future interest rates, and this attenuates the response of long-term rates. Plausibly assuming that the effect of the smaller inflation premium dominates, the response of long-term rates would be smaller under the OSCR than under the discretionary or conservative regimes.

Thus, the model sketched above characterizes according to the type of central banker the response of monetary policy and long-term interest rates to macroeconomic shocks.

- Under a conservative CB, the response of short-term interest rates is greater than under discretion or the OSCR. The response in the OSCR case may be greater or less than the response under discretion.
- The response of long-term rates for conservative and discretionary central banks is larger than in the OSCR case. The response of the conservative CB may be greater or less than that of the discretionary CB.

We draw on these implications in the empirical work below, where, in section 2, interpretations of inflation targeting are characterized as shifts between the discretionary, conservative (or "inflation nutter"), and OSCR regimes. Section 3 then uses the observed behavior of inflation, and of policy and long-term interest rates to distinguish between these interpretations.

2. Inflation Targeting as Shifts Between Central Bank Types

As noted in the introduction, there are several different ways of characterizing inflation targeting commonly invoked. Each one of these characterizations can be grounded to a greater or lesser degree in a portion of the extant monetary economics literature. To enable rigorous comparison of these characterizations with each other, and with reality, we need a common framework for generating differing hypotheses resulting from each interpretation . Our approach is to treat each characterization of inflation targeting as a switch by a central bank between a specific pair of the three types of central banker modelled above — the untrusted discretionary, the strictly-targeting conservative, or the trusted OSCR-following. Some characterizations require an additional distinction to be made between the inflation target adopting central banks on the basis of institutional design, rather than characterizing all adopting central banks as making the same move by announcing an inflation target.[8] With this unified framework, each interpretation of inflation targeting should be associated with a shift in the behavior of (some of) the adopting central banks in response to supply disturbances, as well as in the response of private-sector inflation expectations to the central bank's activities. Testing of those empirical predictions is the subject of the following section.

[8] For example, according to some interpretations of Persson and Tabellini (1993) and Walsh (1995), only those inflation target adopting central banks with formal punishments for failure to meet the targets can be said to switch from the untrusted discretionary regime to the OSCR.

Inflation Targeting as Trust Building

This is the interpretation of King (1997), that inflation targeting allows the central bank to (come close to) follow the optimal state contingent rule. In our framework, this would be a shift from either the discretionary or the conservative type of central banker to the OSCR-following. By providing greater information about its forecasts (and therefore about the nature of the disturbances it faces) and accountability for meeting those forecasts, the central bank gains in the flexibility with which it can respond to shocks. This interpretation would explain the pattern of inflation targeting central banks being able to convince the public that they can accommodate one-time inflationary shocks (e.g., the indirect tax rise in Canada in 1991; the United Kingdom exit from the ERM in 1992) without raising doubt about underlying counter-inflationary resolve, something a conservative central bank is not able to do. It also would explain why all inflation targeting central banks invest so many resources in *Inflation Reports* and other forms of public information provision.

If this interpretation is correct, all three inflation targeters (New Zealand, Canada, and the United Kingdom) examined here should be characterized by smaller movements in inflation expectations (embodied in long-term interest-rates) when the central bank deviates from the target due to unforeseen shocks than seen prior to announcement of inflation targets. In the case of a shift from a conservative or rule-based regime (such as an exchange rate peg) to the OSCR, inflation targeting should also increase the accommodation of shocks by the central bank.

Inflation Targeting as Strict Contracting

According to some interpretations of the models of Walsh (1995) and Persson and Tabellini (1993) of optimal inflation contracts for central bankers, inflation targets can serve as such a contract, but require an explicit punishment mechanism for the central banker's failure to meet the target. This is, of course, embodied in the Reserve Bank Act of 1989 and the "Policy Targets Agreements" in New Zealand. Discussions in that country leading up to target adoption make reference to these sorts of ideas as part of the justification for the design of their regime.[9] Within our framework, the strict contracting interpretation is still characterized as a shift from discretion or conservatism to the OSCR, with the same empirical predictions, but these should only hold for New Zealand in our three country sample.[10] In this characterization, the talk and institutional design of inflation targeting alone are insufficient to shift the central bank's type without such a contract.

Inflation Targeting as Chatty Conservatism

This is an interpretation widespread among inflation targeting skeptics. Worldwide, there is evidence of central banks becoming more conservative with respect to inflation goals. The conservatism could be the result of intellectual commitment to the primacy of the price stability goal as the forward march of knowledge continues, of pressures from internationally

[9] See Bernanke, et al (1999), Chapter 5, for details.

[10] Some could claim that recent additions to the United Kingdom's inflation targeting framework also serve to make the Bank of England strictly contracted. Even were one to accept this interpretation, which appears to us to unduly stretch the meaning of the term "contract", it would apply for only part of the time the Bank of England has been independent, and certainly not to the 1992-1997 period which constitutes most of our sample.

integrated capital markets, or of a general desire to be like the fashionable central bankers of the day. In our framework, this characterization of inflation targeting is represented by a shift from discretion to greater conservatism on the part of the central bank. The institutional aspects of inflation targeting dedicated to transparency should then be seen as mere window dressing or as political concessions necessary for central bankers to maintain this desired shift — either way, the act of central banks talking about their inflation forecasts and publishing detailed reports is a side show. Under this interpretation, talk does not indicate movement towards the OSCR.

This interpretation fits nicely with the fact that both the Bank of Canada and the Reserve Bank of New Zealand expressed explicit commitment to a primary goal of price stability prior to the announcement of inflation targets, while the United Kingdom had joined the ERM in 1990, and all three of these commitments followed years of frustration and disappointment with (what were perceived as) looser monetary strategies. Were this the proper interpretation, the adopting central banks would display diminished accommodative flexibility in response to disturbances. The effect on long-term rates' response to inflation shocks is less clear. As derived in the previous section, the long-term rate response may be greater or less than the response under discretion, depending on whether the larger real rate effect for the conservative targeter is greater or less than the discretionary CB's state-contingent inflation bias. Even when the stability of inflation expectations increases, however, the decline in response of expectations is smaller than that expected were the move to be towards the OSCR instead.

Inflation Targeting as Inflation-Only Targeting

Some would hold that inflation targeting is actually inflation-*only* targeting (to use Ball's [1999] phrase), where inflation targeting means that the central bank literally takes only its inflation goal into account when setting policy. Given the tenor of some proposals in the United States Congress in the 1990s (before it apparently adopted the opinion that current Federal Reserve policy could not be improved upon), and Galbraith's (1999) characterization of inflation targeting as a sign of inflation obsession without any regard for transparency, this view is shared by some inflation targeting advocates and opponents. In our framework, this characterization is the limiting case of the previous, where the shift is to an "inflation nutter" central bank from any lesser degree of conservatism. Inflation-only targeting predicts (when modelled) a shift to near-total inflexibility of monetary policy in response to shocks with far from optimal results.

Rhetoric aside, there is essentially no institutional or historical evidence for such an "inflation-only targeting" interpretation of the intent of most central banks publicly announcing inflation targets in the 1990s, as documented in Bernanke, et al. (1999). Nevertheless, it is more than a straw man or a test of the literalness of language to examine this characterization of inflation targeting. Even if the central bank in question were to have a typically mixed-goal perspective, a la Bernanke and Mishkin (1996), an inflation target designed to be very strict for reasons of accountability could unintentionally still mimic the nutter with significant costs.[11] When almost all inflation targets have central values only a

[11] Friedman and Kuttner (1996) took on the dangerous implications of just such a rule-like policy regime as a warning against inflation targeting in the spirit of then-current congressional proposals for the Federal Reserve.

small amount over the measurement bias in price indices, and those targets with ranges are much narrower than what simulations would indicate are confidence intervals for inflation control, it is plausible that these targets strictly enforced (perhaps by a legislature) would constitute something close to inflation-only targeting. These structural or technical sources of *de facto* conservatism seem particularly likely to matter for a small open economy whose vulnerability to inflation shocks is high.

Inflation Targeting as Cheap Talk of the Weak

An even more skeptical interpretation of inflation targeting than the preceding views is that those central banks which can credibly commit to low inflation do so, and those who cannot, talk about so doing. Central banks which adopt inflation targeting are those banks which have run out of alternatives because they cannot adhere to fixed exchange rate commitments, monetary targeting, or other rule-like behavior. A theoretical grounding for this view is given in Cukierman and Meltzer (1986) and Garfinkel and Oh (1995). In these analyses, the central bank suffers from a two-fold credibility problem: the bias from the possibility of discretionary surprise, and the existence of private information regarding disturbances known to the central bank. By this characterization, talk alone (such as publication of *Inflation Reports* and forecasts) cannot credibly commit the bank to reveal its private information, and so cannot get the central bank to the OSCR.[12] In fact, talking about goals and forecasts is a sign of weakness.

[12] We are grateful to Michelle Garfinkel for an extended elucidation of these models, but we remain responsible for this interpretation and any errors herein.

In our framework, therefore, this characterization is represented by a shift in central bank types from conservatism towards greater discretion. For our sample countries, such an interpretation of inflation targeting seems to make sense only for the United Kingdom, if one were to interpret the exit from the ERM as a sign of weakness.[13] It is more difficult to imagine what made either the Bank of Canada or the Reserve Bank of New Zealand "weaker," in terms of the credibility of their commitments to price stability, at the start of the 1990s than at their already less than credible starting point of the mid-1980s. Empirically, such a shift would imply the reverse of that described as "chatty conservatism," i.e., the central bank would be more accommodative of disturbances, and private-sector inflation expectations would be more responsive to that accommodation.

The mappings of each of the five characterizations of inflation targeting, discussed in this section, on to a shift between a specific pair of central bank types, from section 1, and the empirical implications of those shifts for the behavior of central banks and of inflation expectations, are summarized in Table 1.

[13] Sweden, another inflation targeted not analyzed here, could be characterized in the same way.

Table 1

Interpreting Inflation Targeting as
Shifts Between Types of Central Bankers

Interpretation	Trust-building	Strict Contracting	Chatty Conservatism	Inflation-only Targeting	Cheap Talk of the Weak
Shift from	Discretion or Conservatism	Discretion or Conservatism	Discretion	Discretion	Conservatism
Shift to	OSCR	OSCR	Conservatism	Inflation nutter	Discretion
Countries	All	NZ	All	All	UK
Inflation persistence	decreases	decreases	decreases	decreases	increases
Relative weight on inflation goal	if from Conservatism, decreases	if from Conservatism, decreases	increases	increases	decreases
Response of short-term rate to inflation shocks	if from Conservatism, decreases	if from Conservatism, decreases	increases	increases	increases
Response of long-term rate to inflation shocks	decreases	decreases	ambiguous	ambiguous	increases

3. The effects of inflation targets in practice

The goal of this section is to detect empirically changes in central bank behavior following the adoption of inflation targets, and to characterize those changes in terms of the shifts between central bank types set out in section 2. The investigation focuses on the properties of inflation, the reaction of monetary policy to inflation and real activity, and the response of policy and interest rate expectations to inflation surprises.

The first step is to test the null hypothesis that inflation targeting has no effect at all by examining the inflation rate itself. One obvious test would be to compare the average inflation rate pre- and post-target; if the target is more than "just talk," the inflation rate should fall. Central banks may choose to announce inflation targets following a favorable inflation shock, however, so a reduction in average inflation does not necessarily imply a change in behavior.[14,15]

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[14] See Mishkin and Posen (1997) and Almeida and Goodhart (1998) for evidence of this pattern.

[15] A test with similar limitations would be to assess whether the adoption of inflation targeting reduces the "sacrifice ratio", lowering the cost in terms of foregone employment of a given reduction in inflation. This approach requires additional assumptions about the responsiveness of labor markets to variations in monetary regimes which are largely unsupported for low inflation countries (see Posen [1998]), and which no inflation-target adopting central bank expected to occur over the short lifespans of those regimes to date (see Bernanke et al. [1999]). Hutchison and Walsh (1998) give an alternative view on the New Zealand experience, claiming some shift. In the model discussed above, however, the structural parameter describing the output-inflation tradeoff doesn't change when a new policy regime is adopted. Another strategy involves comparing measures of inflation expectations with the central bank's stated inflation target, as in Svensson (1993) and Johnson (1997). While this provides some evidence on the credibility of the target, it cannot distinguish between interpretations of inflation targeting as an increase in trust or in conservatism.

A more revealing comparison involves the persistence of inflation before and after the adoption of inflation targets. As discussed in section 1, successful inflation targeting — whether achieved through the OSCR or by attaching zero weight on output fluctuations — eliminates the "state-contingent" inflation bias, and renders inflation unforecastable.[16] Zero persistence represents a limiting case, of course; more generally, an increase in conservatism or in trust of the central bank will tend to reduce inflation persistence.[17]

While a decline in inflation persistence signals a change in policy regime, it says nothing about the nature of that change. The second step, therefore, is to ascertain whether the change was achieved through the adoption of more conservative preferences by the central bank — the "chatty conservatism" or "inflation-only targeting" cases — or through trust-building, which would move policy towards the OSCR (whether for all adopting countries, or only for those which take on "strict contracting"). To distinguish between these two possibilities, we rely on the model's implications for the behavior of interest rates, and their response to inflation.

One tactic for uncovering changes in policymakers' preferences is to estimate a policy reaction function, and look for a change in the relative weights on the real activity and inflation terms. The target short-term interest rate, r^*, taken to be the operating instrument of monetary policy, is assumed to depend on the inflation and unemployment "gaps":

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[16] A similar insight is exploited by Ireland (1998) in testing whether the time consistency problem can account for the behavior of U.S. inflation.

[17] The "cheap talk of the weak" interpretation could also be tested in this manner. If true, it would imply higher, more persistent inflation post-target. None of the three countries under study exhibits such a change, so in the interests of brevity this case receives no further discussion.

$$r_t^* = \alpha + \beta(E_t\pi^k_{t\cdot k} - \pi^*) + \gamma(u_t - u^*)$$

where π^* is the central bank's inflation target, $E_t\pi^k_{t+k}$ is expected inflation over some horizon k, u_t is the unemployment rate, and u^* is its target. As in Clarida et al. (1998), a partial-adjustment specification is used to capture central banks' tendency to smooth interest rates,

$$r_t = (1-\rho)r_t^* + \rho r_{t-1} + e_t \quad .$$

Average inflation rate over the preceding six months, π^6_t, is used as a proxy for expected future inflation. The two equations can then be combined to yield the following regression equation which can be estimated using OLS:

$$r_t = b_0 + b_1\pi^6_t + b_2u_t + e_t \quad .$$

The target inflation and unemployment rates are subsumed into the constant term, while the b_1 and b_2 coefficients can be interpreted as $(1-\rho)\beta$ and $(1-\rho)\gamma$, respectively. If inflation targeting involves the adoption of more conservative preferences, we would expect to see an increase in b_1 relative to b_2; in the trust-building case, no change would be expected.

The reaction function approach has its limitations, however, as it says nothing directly about the response of policy and inflation expectations to macroeconomic shocks — both of which are key to distinguishing the competing hypotheses. In addition, to the extent that inflation targeting reduces inflation persistence, lagged inflation becomes less satisfactory as a proxy for future inflation.[18]

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[18] In this limiting case of perfect inflation targeting, inflation fluctuations would be unforecastable; consequently, the inflation term in the reaction function would be completely uninformative about future inflation. Even a less-than-perfect inflation target could reduce the predictability of inflation to the point where it would create finite-sample problems for instrumental variables estimation (see Staiger and Stock [1997]). Bernanke and Woodford (1998) discuss related theoretical issues raised by targeting expected inflation.

Both of these observations motivate our second tactic, which is to examine the response of short-and long-term interest rates to inflation surprises. Comparing the responses pre- and post-target, and matching the changes to the predictions summarized in Table 1 allows us to distinguish between the alternative interpretations of inflation targeting. Moreover, inflation's unforecastability is not an issue in this approach, as the central bank's reaction to unexpected inflation can be observed even when expected inflation is constant.

To characterize the response of monetary policy and expectations to inflation shocks, we use impulse response functions from a VAR involving inflation, unemployment, short- and long-term interest rates. The identifying assumptions used to extract an inflation shock from the VAR are broadly consistent with our model, and with conventional timing assumptions. Specifically, none of the other variables is assumed to have a contemporaneous effect on inflation, so the inflation shock can be interpreted as the residual from a forecasting regression involving lagged inflation, unemployment, and interest rates. Inflation shocks can affect unemployment contemporaneously, consistent with their interpretation as a supply disturbance. As expectations presumably react immediately to news, the bond rate is allowed to respond contemporaneously to inflation, unemployment and monetary policy shocks. Finally, in keeping with our assumptions about the central bank's information set, monetary policy is assumed to respond to current-period values of inflation and unemployment.[19]

[19] Ruled out by this identification scheme are contemporaneous effects from unemployment to inflation, from monetary policy to inflation and unemployment, and from bond rates to any of the other three variables. This leads to a just-identified triangular decomposition of the covariance matrix that is similar, but not identical to the standard Choleski factorization.

United Kingdom

We turn first to the results for the United Kingdom, which adopted an inflation targeting policy after exiting the ERM in September 1992. In terms of explicit intent and design, the Bank of England's framework comes closest to the model of using institutionalized transparency to achieve the OSCR (see King [1997] and Bernanke, et al. [1999], ch. 7). Unlike in Canada and New Zealand, changes in the Bank's mandate, independence, and governor all took place *after* inflation target adoption, making this in some sense the cleanest test of inflation targeting itself. On the face of it, the UK's adoption of an inflation target would appear to be untinged by a movement towards increased anti-inflationary conservatism; if anything, the unwillingness to remain in ERM and sacrifice domestic real-side goals for the sake of a strong pound and price stability could be interpreted as replacing anti-inflationary commitment with cheap talk.

The experience under an inflation target is compared with the period from 1984 through 1989. The two years in which Britain participated in the ERM, and the eight months leading up to it, are excluded from the analysis on the grounds that the period represents a brief interregnum, dominated by transition dynamics in and out of that regime.[20] As with all three inflation targeters examined here, the average rate of inflation is indeed lower during the targeting period: 2.7 percent, compared with 4.5 percent for the 1984–9 period.

[20] Unusual inflation volatility which characterized this period — including one month in which the annualized rate exceeded 20 percent — is another reason to exclude the months leading up to the ERM. The results are qualitatively similar if this period is included, however.

Table 2 reports measures of inflation persistence, and changes in its behavior between the two subsamples, based on seasonally-adjusted RPIX (consumer prices excluding mortgage interest payments). In the pre-target period, the coefficients on lagged inflation itself are positive, but statistically insignificant; the persistence in the inflation rate is captured instead by the negative, highly significant coefficient on the unemployment rate.[21] This pattern changes after the adoption of inflation targets. The coefficients on unemployment and the first lag of inflation are effectively zero, while the coefficient on the second lag is negative and statistically significant. This pattern is inconsistent with the suggestion that "cheap talk" replaced the discipline imposed by the ERM.

Table 3 reports an estimate of the reaction function allowing the coefficients to change with the adoption of the inflation target. Pre-target, the coefficient on inflation is a highly significant 0.23, which, given the coefficient on the lagged interest rate, implies β=1.64, a greater than one-for-one response of the overnight rate to inflation. Post-target, the coefficient falls to an insignificant 0.11, although the difference between the two is not significant.[22] The smaller coefficient suggests a move away from conservatism, but it may also be an artifact the reduction in inflation persistence. There also appears to be a modest increase in the weight on unemployment post-target, although neither it, nor its change, is statistically significant.

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[21] The model outlined in section 1 implies a positive correlation between unemployment and inflation, rather than the negative correlation found in the data. The observed negative correlation is probably the result of demand shocks, which are absent from the model.

[22] Focusing on the 18 quarters from 1992Q4 through 1997Q1, Nelson (1999) is able to detect an increase in β in an instrumental-variables specification.

Results of our third test for the U.K., concerning the interest rate response to inflation shocks, are more distinct, and suggest a shift from a discretionary policy regime to one approximating the OSCR. The results appear in Figure 1, where the solid line is the estimated impulse response function, and the dotted lines represent the bounds of the 95% confidence interval. Pre-target, the response is sharp: a one percentage point (annualized rate) inflation shock generates an increase in the short-term rate peaking at 20 basis points, and an increase in the long rate of roughly 7 basis points. Both are significant at the .05 level. Considered in isolation, the interest rate responses prior to inflation target adoption are difficult to interpret. In the model of section 1 above, inflation shocks elicit a contractionary policy response regardless of policy regime (including discretion). Similarly, the rise in bond rates may reflect an increase in inflation expectations (consistent with a "weak" central bank), or it may embody higher expected real short-term rates (consistent with a "conservative" central bank).

Comparing the pre-target with the post-target responses in Figure 1 is more revealing about the nature of the regime change. Inflation targeting is associated with an attenuated response of both short- and long-term rates: the increase is only 3 basis points for both maturities, and neither response is significant at the 0.05 level. Given the wide confidence interval associated with the pre-target impulse response functions, a formal test of equality between the two would fail to reject the hypothesis of no change. Nonetheless, it is hard to reconcile the muted (and precisely-estimated) post-target policy response with an increase in conservatism, let alone a move to "inflation-only targeting," which would imply a significant amplification in the response of both interest rates. Furthermore, the absence of a significant

rise in the bond rate, along with the diminished inflation persistence, rules out the "cheap talk" interpretation. Instead, the reduced inflation persistence, milder policy response and lack of an "inflation scare" in bond rates post target are all consistent with the "trust building" interpretation of inflation targeting.

Canada

As seen in the United Kingdom, Canadian inflation fell by about 2.5 percent (from 3.8 to 1.3 percent) following the adoption of inflation targets in February 1991.[23] Unlike what was seen in the United Kingdom, however, there is little evidence of a change in the time-series properties of inflation post-adoption. As shown in Table 4, the inflation rate is essentially unforecastable both before and after this date: coefficients on lagged output and inflation are small and statistically insignificant in both subsamples. Diagnostic LM tests show no evidence of higher order serial correlation, and the R^2s from the two regressions are only 0.01 and 0.04, respectively. This lack of forecastability is inconsistent with discretionary policy either pre- or post-target.[24] One possible explanation, if Canadian inflation targeting represents an increase in conservatism, is that the relevant regime change can be dated prior to the adoption of the inflation target, to the appointment of Governor John Crow at the Bank

[23] These figures, and the results which follow, are based on the target inflation measure obtained from the Bank of Canada that removes the effects of changes in the Goods and Services Tax (GST).

[24] Obviously, there are other factors — the exchange rate, commodity prices — that might be related to Canadian inflation. But none of these omitted variables generate serially correlated movements in inflation.

of Canada, or to his Hansen Lecture of 1988 declaring price stability to be the sole long-run goal of Canadian monetary policy (see Mishkin and Posen [1997]).

The question remains open, however, as to whether the Bank of Canada achieved these results through conservatism, or through trust-building. The estimated reaction function reported in Table 5 sheds little light on this question, perhaps because of the lack of predictability in Canadian inflation. The coefficients on the average inflation rate are small and statistically insignificant, as are the coefficients on the unemployment rate. One plausible interpretation of these puzzling results is that, despite the stated policy of inflation targeting, Canadian monetary policy has been more focused on the exchange rate. Indeed, even after February 1991, the Canadian overnight rate has been punctuated by sharp increases without any apparent link to domestic economic conditions.[25] Shifts in fiscal policy may also have been a factor affecting monetary policy (see, e.g., Clinton and Zelmer [1997]).

Clearer evidence is provided by the impulse responses from the VAR, which show smaller policy and bond rate responses post-target. As shown in Figure 2, a 1% inflation shock elicited a sharp, statistically significant 15 basis point response in the overnight rate pre-target; post-target, the response is not statistically distinguishable from zero. The response of the bond rate goes from a barely-significant 5 basis points pre-target to essentially zero post-target. As in the U.K., the attenuated policy response and non-response of bond rates post-target together rule out a sharp increase in conservatism, and the combination,

[25] Notable examples include a 300 basis point increase in early 1986, a 270 basis point spanning late 1992 and early 1993 — both rapidly reversed — and, more recently, a 100 basis point increase in September 1998.

along with the lack of any inflation persistence, is broadly consistent with the trust-building interpretation of inflation targeting.

New Zealand

The last case considered is that of New Zealand, which adopted inflation an inflation target in January 1990.[26] As with the U.K. and Canada, average inflation has been lower post-target: 1.9 percent, versus 8.1 percent over the 1982 through 1990 period. And like the U.K., the inflation rate exhibits much less persistence after the adoption of the inflation target, as shown in Table 6. Prior to 1991, the estimated AR(1) coefficient of 0.64 indicates a significant amount of inflation persistence. This coefficient drops to essentially zero post-target, with no evidence of residual correlation or an omitted lag on inflation. While this difference is striking and large enough to be economically meaningful, it is statistically insignificant. The effects of the unemployment rate on inflation are small and statistically insignificant in both subsamples.

The estimated reaction function coefficients reported in Table 7 are consistent with a strong policy response to expected inflation both pre- and post-target. Before target adoption, the coefficient on the inflation rate is a highly significant 0.42. (The two-quarter average, π^2_t, takes the place of the six-month average used in the monthly regressions reported in the UK and Canadian cases). With a coefficient of 0.59 on the lagged short-term rate, this implies a roughly one-for-one response of the interest rate to expected inflation. The size of the

[26] Monthly data on inflation and other variables are not available for New Zealand. The small number of quarterly observations in the pre- and post-target subsamples, severely limits our ability to make precise inferences from the data.

coefficient increases somewhat post-target to 0.68, but the difference is not statistically significant. With respect to real activity, monetary policy appears to have been more accommodative post-target, with the coefficient on the unemployment rate going from a statistically insignificant 0.57, to a significant –0.18. The change in the coefficient is itself significant.

The results from the VAR-based impulse response functions also show a stronger response to inflation shocks since the adoption of the inflation target. As depicted in the upper-left panel in Figure 3, the two-quarter response of the short rate pre-target was roughly 40 basis points; post-target, it is nearly 70.[27] Both are statistically significant, but the large standard errors associated with the post-target response would not formally reject a no change hypothesis. Similarly, the response of the bond rate post-target is nearly four times as large, but this response is very imprecisely estimated.

The reduction in the level and persistence of New Zealand's inflation rate clearly show a significant change in policy accompanied the adoption of the inflation target. Although most of the evidence on the behavior of interest rates arguably points to the "chatty conservatism" interpretation, the change of sign to a significant negative short-term interest rate to unemployment post-target muddies the picture somewhat. As in the United Kingdom and Canada, there is no evidence to suggest an "inflation-only targeting" scenario. The increase in conservatism seen in New Zealand appears more in keeping with the discussion in section 2 above, where New Zealand's explicit contracts and low and narrow target range

[27] Because the New Zealand analysis uses the available quarterly data, comparisons between the magnitude of its responses and those of the U.K. or Canada, which use monthly data, are uninformative.

(considering the economy's small size and high degree of openness) lead unintentionally to greater conservatism.

Taken together with the results from Canada and the U.K., it is also clear that the New Zealand evidence does not support the "strict contracting" view of inflation targeting. The tight constraints imposed by the New Zealand framework did not produce noticeably lower inflation persistence or a closer approximation to the OSCR than the less strict — though still transparent — regime of the United Kingdom. In fact, the apparent failure of the New Zealand strict contracting approach to dampen the response of policy and of inflation expectations to inflation shocks underscores the distinction between the "trust-building" and "conservative" approaches to inflation targeting.

4. Conclusions

It exaggerates only slightly to suggest that the widespread adoption of inflation targeting has acted as something of a Rorschach test for observers of monetary regimes. Those inclined to be skeptical of all but hard and fast monetary rules have viewed inflation targeting as a form of political window-dressing for the capital market pressures towards price stability at best, and as cheap talk in lieu of credible policy at worst. Alternatively, those who fear crusades for price stability and disregard of output stabilization by central banks have seen in inflation targeting an open declaration of obsession, that nothing but inflation matters. The central bankers adopting inflation targeting regimes have themselves, however, given pride of place to the role of transparency in the inflation targeting framework, both as an end unto itself and as a means to greater accountability and flexibility. Even amongst the adopting central banks, however, there has been some variation in the degree of explicit contracting (with punishment) binding the central bank to strict pursuit of the inflation target.

In essence, the adoption of inflation targeting constitutes a test of whether central bank communication to the public can substitute for strict and simple rules. From the monetary policymaker's point of view, this is the practical aspect of the long-standing academic "rules-versus-discretion" debate. In a world where both central bank information about the economy, and control of it, is imperfect, what matters is when a central banker must deviate from her long-term goal of price stability in the face of uncertain predictions or negative events.[28] Debates over the appropriate target level of inflation or the relative weight of

[28] See Laubach and Posen (1997b) for statements by central bankers in Germany and Switzerland characterizing their success as the management of such short-run flexibility.

inflation versus output goals may best be seen as political decisions which may be ideological, but which tend to get settled for extended periods, rather than being revisited at every meeting to set interest rates.[29] That is why our framework for characterizing the effects of inflation targeting focusses precisely on — and is able to differentiate the extant interpretations of inflation targeting on the basis of — predictions of how talk by central bankers relates to their behavior in response to shocks.

The evidence presented in this paper indicates that talk by central banks matters after all. Mapping five different interpretations of inflation targeting on to shifts between specific types of central bankers (untrusted discretionary, strictly conservative, trusted OSCR-following) allowed us to create distinct predictions about the changes in the accommodativeness of central bank behavior and in the stability of inflation expectations post-target adoption consistent with each interpretation. The interpretation that inflation targeting simply represents cheap talk, and would be consistent with a move from conservatism towards greater discretion in (and public distrust of) the commitment to price stability, is rejected for all three economies examined, including for the ERM-exiting United Kingdom (the economy for which the strongest *prima facie* case for such an interpretation could be made). Though central bank talk about inflation targets is not cheap, however, neither is it a literally binding move to "inflation nutter" behavior — there is no evidence that the sort of "inflation-*only* targeting" hoped for or feared by some who hear the words "inflation targeting" was practiced by any of the three central banks considered here. In

[29] This is consonant with the distinction between goal and instrument independence in Debelle and Fischer (1994), as well as the distinction between constitutional and policy phases of political economy in Dixit (1996).

short, central bank talk to the public can avoid imposing rule-like behavior yet still serve a purpose

Whether talk alone is sufficient to earn the central bank enough trust to allow it to follow the optimal state contingent rule, or whether the talk of inflation targeting represents a shift from discretion towards greater conservatism short of inflation obsession, is not entirely settled, though the bulk of evidence analyzed here supports the trust-building interpretation. Adoption of the Bank of England's inflation targeting framework, which, as described in King (1997) and documented in Bernanke, et al (1999), Chapter 7, goes to great institutional lengths to rely on transparency instead of formal rules, seems to produce exactly the results we would have predicted for the "trust building" interpretation of inflation targeting: a decline in inflation persistence as well as level, an increase in central bank accommodation of real side shocks, *and* a decrease in long-run inflation expectations' response to such accommodation. Similarly, the adoption of inflation targeting by the Bank of Canada looks more like a shift from a discretionary to a trusted OSCR-following type of central bank than a shift to a rabid conservative, on the criteria of central bank accommodativeness and inflation expectation response to real shocks (and inflation persistence did not rise)[30].

On the basis of these results juxtaposed with those for New Zealand, the interpretation of inflation targeting as strict contracting, meaning that not only transparent talk, but also an explicit legal arrangement of strict target enforcement and of central bank punishment for

[30]Canada's results of inflation targeting are less sharply defined, perhaps due to developments in its budgetary and exchange rate environment over the period. It is useful to remember that whatever central banks do, talk or otherwise, cannot overcome major changes in a country's fiscal and international environments.

target misses is required to move the central bank towards the OSCR, is rejected. In fact, the Reserve Bank of New Zealand is the central bank of the three examined here which appears most to be moving towards chatty conservatism, not towards the more flexible and trusted OSCR, with the adoption of inflation targeting (though certainly not all the way towards inflation-only targeting). At the same time, the results of inflation target adoption in New Zealand, Canada, and the United Kingdom for the level and persistence of inflation appear to be essentially the same, though the Bank of England and the Bank of Canada did without the strict accountability apparatus and other institutional constraints exemplified by the Reserve Bank of New Zealand's framework (see Walsh [1995] and Bernanke et al. [1999], ch. 5), and even without full central bank independence for much of the targeting period. A plausible explanation is that the New Zealand inflation targeting framework's emphasis on legal accountability and strict targeting unintentionally produced more conservative behavior than was desired or ultimately necessary. The broader import of this set of results is that increasing central bank transparency through the talk about forecasts and goals embodied in inflation targeting appears to improve central bank response to supply shocks while enhancing public trust of the central bank's long-run target commitment — and it does so without necessarily imposing rule-like inflexibility on monetary policy.

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Table 2

Time Series Properties of Inflation: United Kingdom

Dependent variable = seasonally adjusted consumer price inflation, excluding mortgage interest

	Coefficient on:						LM tests: serial correlation		
Sample	const	π_{t-1}	π_{t-2}	u_{t-1}	R^2	SE	lag 1	lags 1-4	π_{t-3}
Pre-target	6.94	0.17	0.03	–0.35	0.19	1.90	0.66	4.47	0.01
	(4.06)	(1.40)	(0.25)	(2.63)			(0.41)	(0.35)	(0.91)
Post-target	3.13	0.01	–0.30	0.04	0.09	1.53	0.32	5.17	0.27
	(4.12)	(0.12)	(2.70)	(0.62)			(0.57)	(0.27)	(0.61)
Difference:	–3.81	–0.15	–0.33	0.39					
post–pre	(2.12)	(0.95)	(2.01)	(2.55)					

Notes: Data are monthly. The pre-target sample runs from January 1984 through December 1989, and the post-target sample runs from October 1992 through April 1999. Numbers in parenthesis below the parameter estimates are *t*-statistics; those in parenthesis below the Lagrange Multiplier (LM) test statistics are p-values. The "Difference" line of the table is based on a regression in which a post-target dummy variable is interacted with each coefficient.

Table 3

Monetary Policy Reaction Function: United Kingdom

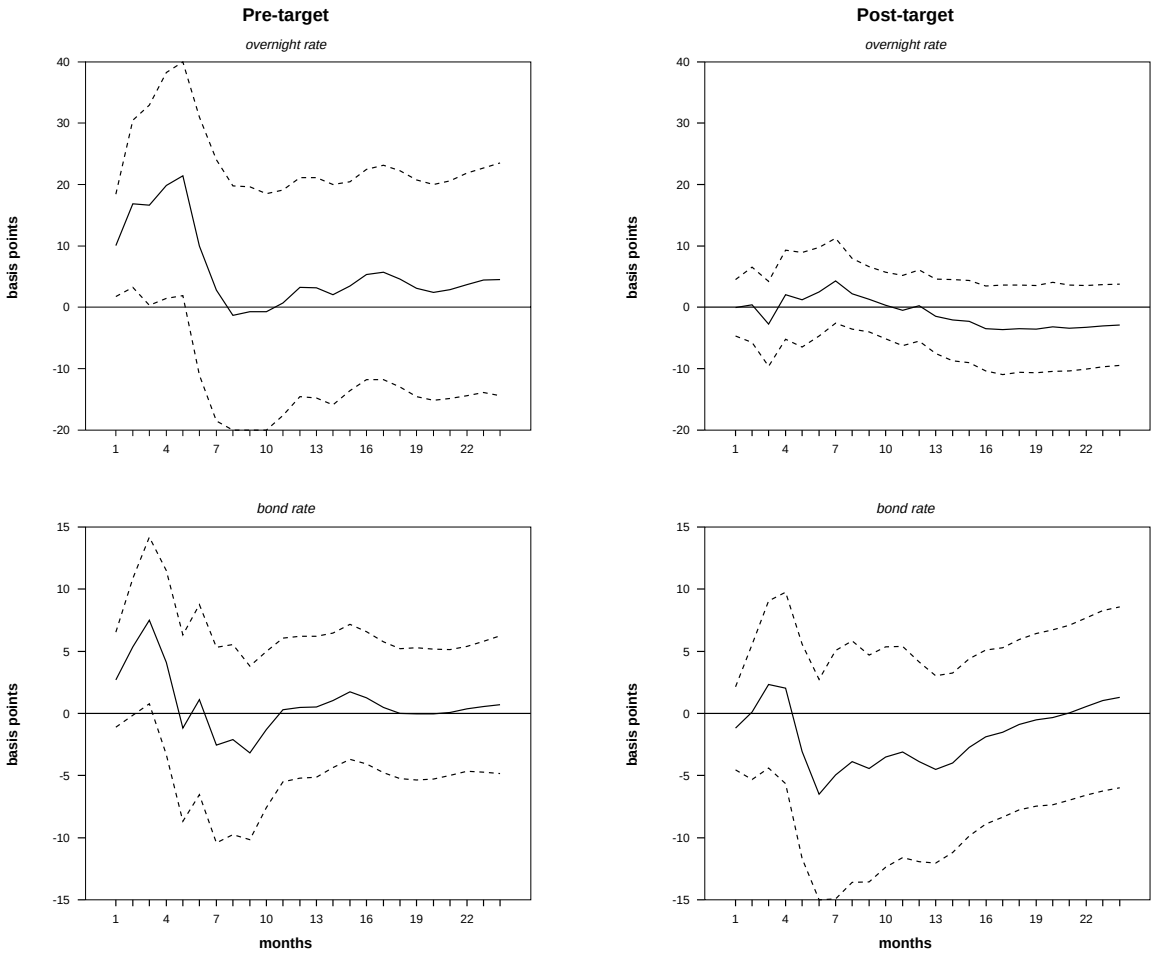
Dependent variable = overnight interest rate

	Coefficient on:					
Sample	constant	r_{t-1}	π^6_t	u_t	R^2	SE
Pre-target	0.83	0.86	0.23	–0.03	0.84	0.80
	(0.89)	(13.23)	(2.23)	(0.56)		
Post-target	1.33	0.79	0.11	–0.06	0.87	0.31
	(2.26)	(16.30)	(1.55)	(1.97)		
Difference:	0.50	–0.06	–0.12	–0.03		
post–pre	(0.45)	(0.79)	(0.97)	(0.43)		

Notes: Numbers in parentheses are *t*-statistics from standard errors corrected for third-order serial correlation. See also notes to Table 2.

Figure 1

Response of Interest Rates to Inflation Shocks: United Kingdom



Notes: Estimated impulse responses functions are computed from a four-variable VAR involving six lags of: seasonally-adjusted consumer price inflation excluding mortgage interest, the unemployment rate, the overnight interest rate, and the government bond rate. The assumptions used to identify the shocks are described in the text. The 95% confidence intervals are derived from the standard error computed via monte-carlo integration. See also notes to Table 2.

Table 4

Time Series Properties of Inflation: Canada

Dependent variable = adjusted consumer price inflation, excluding GST

	Coefficient on:					LM tests: serial correlation		
Sample	const	π_{t-1}	u_{t-1}	R^2	SE	lag 1	lags 1-4	π_{t-2}
Pre-target	5.49	–0.01	–0.19	0.01	2.62	0.61	2.83	1.66
	(2.71)	(0.04)	(0.88)			(0.43)	(0.59)	(0.20)
Post-target	0.02	–0.16	–0.15	0.04	1.86	0.01	5.09	0.04
	(0.01)	(1.87)	(0.75)			(0.91)	(0.28)	(0.85)
Difference:	–5.47	–0.16	0.34					
post–pre	(1.79)	(1.07)	(1.10)					

Notes: Data are monthly. The pre-target sample runs from February 1984 through January 1991, and the post-target sample runs from February 1991 through September 1998. Numbers in parenthesis below the parameter estimates are *t*-statistics; those in parenthesis below the Lagrange Multiplier (LM) test statistics are p-values. The "Difference" line of the table is based on a regression in which a post-target dummy variable is interacted with each coefficient.

Table 5

Monetary Policy Reaction Function: Canada

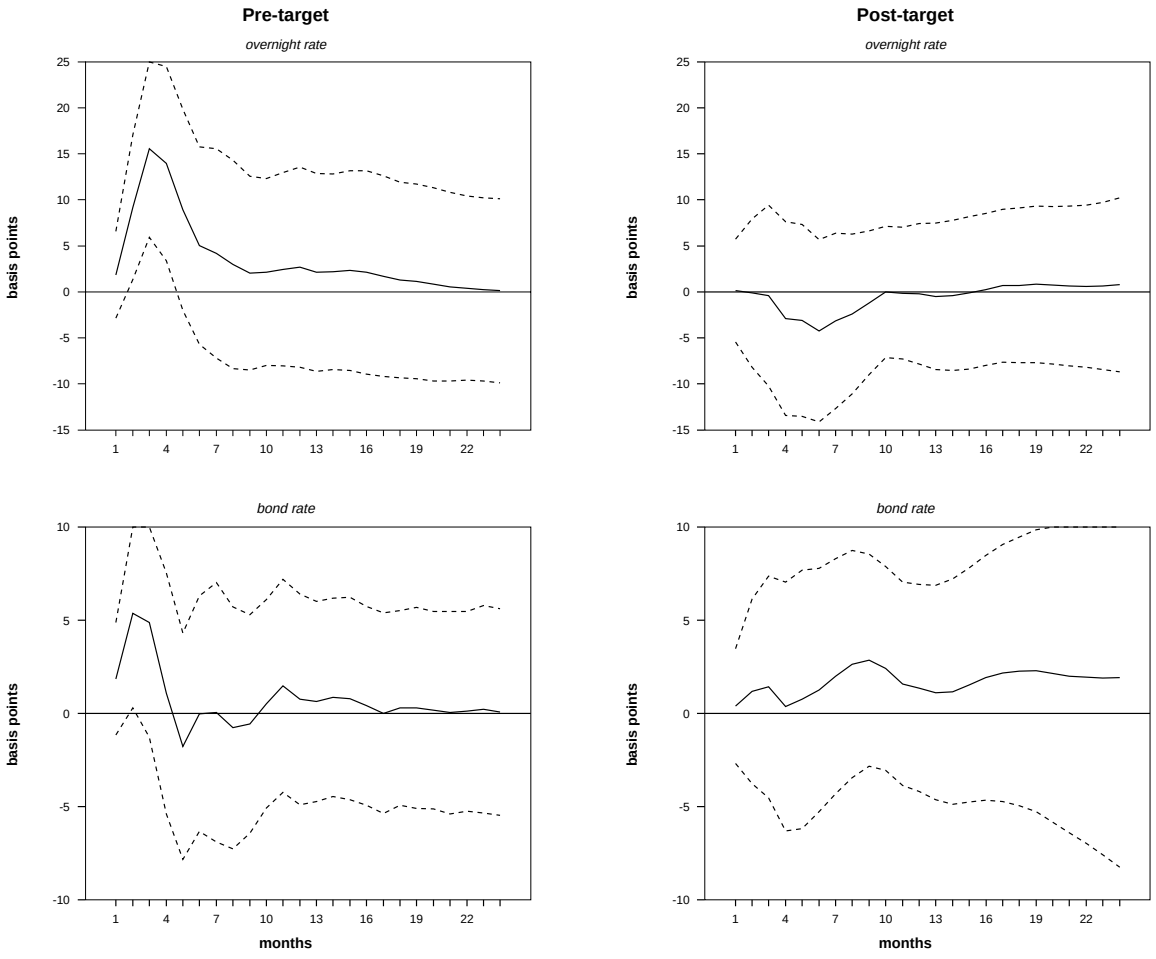
Dependent variable = call money rate

	Coefficient on:					
Sample	constant	r_{t-1}	π^6_t	u_t	R^2	SE
Pre-target	1.05	0.93	0.09	–0.08	0.91	0.59
	1.89	(24.29)	(1.04)	(1.45)		
Post-target	0.76	0.92	–0.06	–0.03	0.93	0.49
	(1.36)	(33.33)	(1.05)	(0.48)		
Difference:	–0.29	–0.01	–0.15	0.05		
post–pre	(0.36)	(0.23)	(1.46)	(0.57)		

Notes: Numbers in parentheses are *t*-statistics from standard errors corrected for third-order serial correlation. See also notes to Table 4.

Figure 2

Response of Interest Rates to Inflation Shocks: Canada



Notes: Estimated impulse responses functions are computed from a four-variable VAR involving six lags of: the seasonally-adjusted rate of CPI inflation excluding GST, the unemployment rate, the call money rate, and the government bond rate. The assumptions used to identify the shocks are described in the text. The 95% confidence intervals are derived from the standard error computed via monte-carlo integration. See also notes to Table 4.

Table 6

Time Series Properties of Inflation: New Zealand

Dependent variable = adjusted consumer price inflation, excluding credit services

	Coefficient on:					LM tests: serial correlation		
Sample	const	π_{t-1}	u_{t-1}	R^2	SE	lag 1	lags 1-4	π_{t-2}
Pre-target	4.27	0.64	–0.29	0.49	3.51	0.31	6.48	0.30
	(1.04)	(3.62)	(0.48)			(0.58)	(0.17)	(0.58)
Post-target	2.25	–0.06	–0.02	0.01	0.85	2.51	3.99	0.03
	(2.66)	(0.35)	(0.24)			(0.11)	(0.41)	(0.85)
Difference:	–2.02	–0.70	0.27					
post–pre	(0.51)	(1.29)	(0.52)					

Notes: Data are quarterly. The pre-target sample runs from 1982Q1 through 1990Q4, and the post-target sample runs from 1991Q1 through 1998Q2. Observations associated with two sharp, one-time shifts in the price level in 1986Q4 and 1989Q3 are deleted. Numbers in parentheses below the parameter estimates are *t*-statistics; those in parentheses below the Lagrange Multiplier (LM) test statistics are p-values. The "Difference" line of the table is based on a regression in which a post-target dummy variable is interacted with each coefficient.

Table 7

Monetary Policy Reaction Function: New Zealand

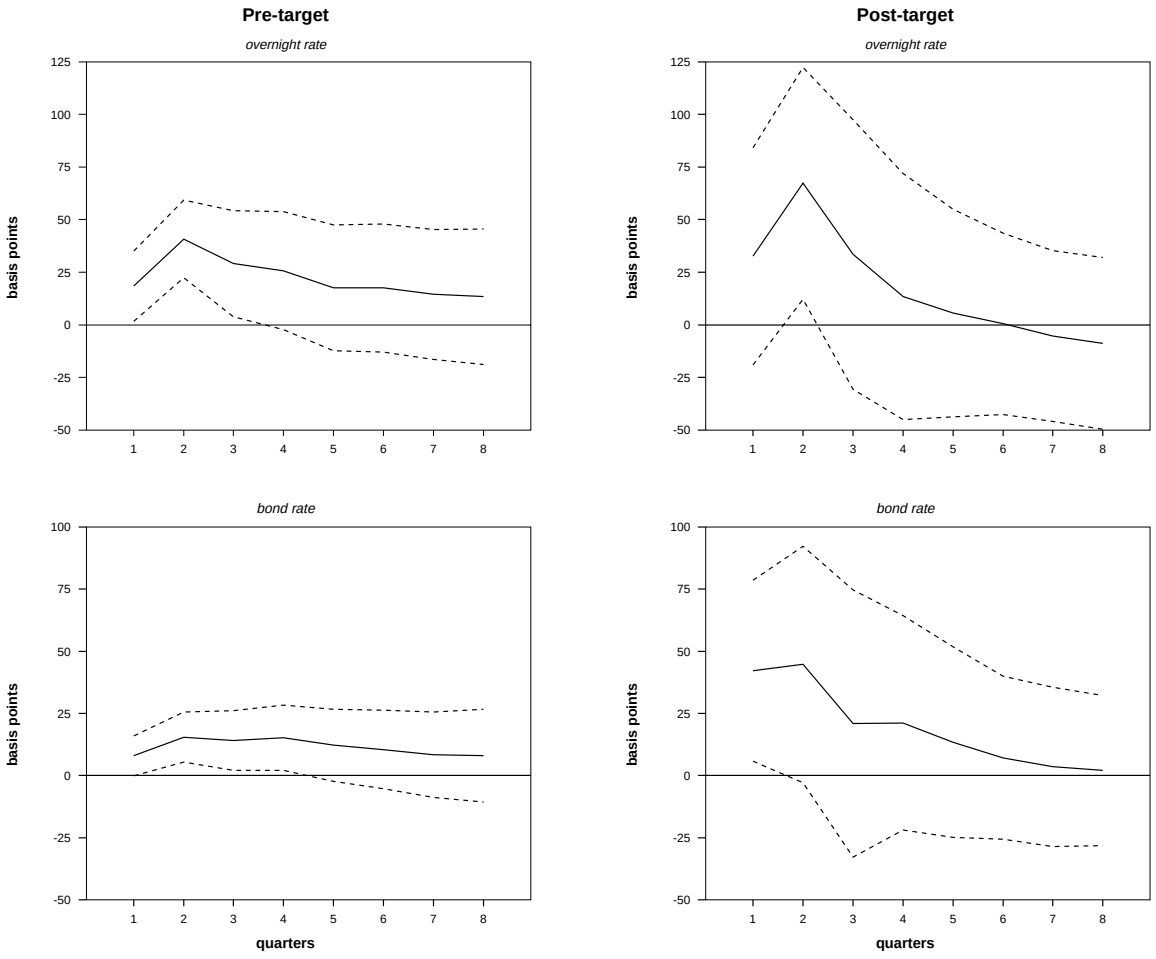
Dependent variable = RBNZ discount rate

	Coefficient on:					
Sample	constant	r_{t-1}	${\pi^2}_t$	u_t	R^2	SE
Pre-target	–0.15	0.59	0.42	0.57	0.64	2.73
	(0.04)	(6.87)	(2.44)	(1.76)		
Post-target	3.90	0.56	0.68	–0.18	0.70	0.91
	(3.36)	(5.40)	(2.59)	(2.59)		
Difference:	4.04	–0.03	0.26	–0.75		
post–pre	(1.11)	(0.22)	(0.81)	(2.18)		

Notes: Numbers in parentheses are *t*-statistics from standard errors corrected for first-order serial correlation. See also notes to Table 6.

Figure 3

Response of Interest Rates to Inflation Shocks: New Zealand



Notes: Estimated impulse responses functions are computed from a four-variable VAR involving two lags of: the seasonally-adjusted rate of CPI inflation excluding credit services, the unemployment rate, the discount rate, and the government bond rate. The assumptions used to identify the shocks are described in the text. The 95% confidence intervals are derived from the standard error computed via monte-carlo integration. See also notes to Table 6.