

Pierre L. Siklos is professor of economics at Wilfrid Laurier University, Waterloo, Ontario Canada. Material in this paper was presented at the Midwest Macroeconomics Conference held at the Federal Reserve Bank of St. Louis on April 17-19, 1998. Financial Assistance from the Social Sciences and Humanities Research Council of Canada under grant 410-98-0071 is gratefully acknowledged. The author thanks Richard Burdekin, Bill Gavin, David Mayes, Kent Koch, David Laidler, Chris Neely, and Mark Wohar for helpful suggestions on early drafts.

# Inflation-Target Design: Changing Inflation Performance and Persistence in Industrial Countries

Pierre L. Siklos

**F**inding a monetary regime that can deliver some form of price stability, as well as satisfactory economic performance, always has been explained more convincingly in theory than in practice. Consequently, governments have, over time, experimented with policies ranging from some metallic standard (for example, gold, silver, or bimetallic) to various forms of exchange rate pegging (for example, Bretton Woods or the European exchange rate mechanism) and the introduction of currency boards (as in Hong Kong, Argentina, or Estonia, for example). The latest fashion in monetary policy formulation is a renewed interest in inflation targeting.<sup>1</sup> The policy has attracted the attention of policymakers and the public alike. Although imperfect, inflation targeting seemingly lacks some of the drawbacks of other policy regimes.

The rationale for inflation targeting and the ingredients of an inflation-targeting policy are reviewed briefly in the following two sections.<sup>2</sup> There has, however, been relatively less emphasis placed on comparative assessments of inflation performance under inflation targeting among the group

of countries that have formally adopted the policy. Does inflation targeting influence the time series properties of inflation? To explore this issue, I estimate a simple model that illustrates whether inflation persistence has changed in a significant fashion in inflation targeting vs. non inflation-targeting countries. The paper concludes by noting that it is too early for a definitive assessment of inflation targeting. Yet, from the standpoint of economic analysis and empirical performance to date, a policy of inflation control offers as good a chance as any policy regime to produce consistently good macroeconomic performance.

## THE DESIGN OF INFLATION TARGETS

The Bretton Woods era of pegged exchange rates was notable for the absence of large international economic shocks (Bordo, 1993). When these did take place, most industrial countries eventually allowed their currencies to float vis-à-vis the U.S. dollar. Similarly, the shock generated by German economic reunification in 1990 produced strains in the European Monetary System that quickly illustrated its lack of flexibility. Political considerations have always loomed larger in any decision to peg or revalue an existing peg, often with significant economic consequences. From the gold standard (Eichengreen, 1992) right up to the present Asian currency crisis (Willett, 1998), political economy considerations surrounding fixed exchange rate regimes often have prevented them from becoming an adequate source of macroeconomic discipline.

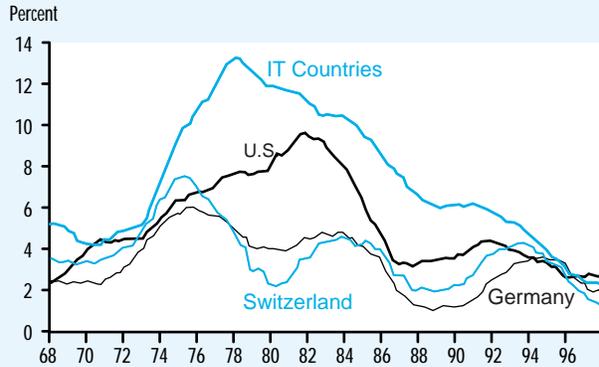
At the heart of questions involving the choice of policy regimes is the notion of credibility. An inflation target can enhance central bank credibility in many ways. First, inflation targeting can help clarify the tasks of the central bank and quantify them in an objective and

<sup>1</sup> See, for example, Berg and Jonung (1998) for the Swedish experience with price-level targeting during the 1930s. In the United States, there have been many attempts to reform the Federal Reserve Act to mandate some form of inflation control. In the 1920s, congressional bills that would have made price stability the target for the Fed failed, as did several bills introduced in the 105th Congress (1997).

<sup>2</sup> See Haldane (1995), Leiderman and Svensson (1995), Laidler (1997), Mishkin and Posen (1997), Bernanke, Laubach, Mishkin and Posen (1999), and the Federal Reserve Bank of Kansas City (1996) for comprehensive overviews.

Figure 1

## The Evolution of Inflation in Selected Countries



NOTE: CPI inflation rates are defined as a 20 quarter moving average. The inflation targeting countries are the ones listed in Table 1 and the simple average of their inflation rates was used.

Five of the eight countries specify a target as a range, and the desired target is usually the middle of the target range, even if this is not always made explicit. Only New Zealand has enshrined the target in legislation governing central bank operations. In the remaining inflation-targeting countries, the target represents an understanding between the government and usually the head of the central bank—that is, the governor or president—and is not interpreted as a legislated objective. After adopting transitional measures intended to lower inflation expectations gradually, four of the eight central banks define a term over which the inflation target is to be met. In other countries the target is either indefinite or can be changed by an amendment to central bank legislation or by government directive.

There are different procedures for deciding who actually is responsible for setting the inflation target. The target is determined by the central bank in four of eight countries, the government sets the target in two other countries, and the decision is joint in the two remaining cases. In six of the eight countries with an inflation target, central banks provide (either voluntarily or by mandate) a formal separate report on the inflation outlook in their country. Even in countries in which the central bank does not produce a formal report, some reporting requirement exist. Finally, only three of the eight central banks publish explicit inflation forecasts. An important area of current research is the role of inflation forecasts in the monetary policy process.<sup>6</sup>

## INFLATION PERFORMANCE IN A CROSS-SECTION OF COUNTRIES

Figure 1 plots the five-year inflation rate for the inflation-targeting countries, as well as for the United States, Germany, and Switzerland, since the late 1960s using quarterly data.<sup>7</sup> The latter countries are considered to have the best long-run inflation performance among industrialized nations not formally adopting an inflation

verifiable manner. Second, by adopting statutes that ensure the autonomy of the central bank, the location of the responsibility for meeting the targets also is well defined. Central bank accountability and transparency then take on important roles. Third, experience with an inflation-targeting regime can readily influence expectations of inflation that are central in economic agents' decision-making process.

In general, all inflation targets, as currently administered, have a few common elements such as the requirement to achieve a desired inflation rate in terms of a cost of living index, usually the consumer price index (CPI). Inflation-targeting countries specify caveats for these targets, however, usually to prevent an anomalous monetary policy shock in the event of negative aggregate supply shocks.<sup>3</sup> As a result, the operational guide for monetary policy is often stated in terms of core or underlying inflation—that is, total CPI inflation exclusive of food and energy prices and possibly indirect taxes.<sup>4</sup> Finally, the calculation period for inflation is, with one exception, the year-on-year percent change in the targeted price index. Table 1 provides a succinct summary of the basic elements of an inflation-targeting regime in eight countries that formally target inflation; that is, they announce explicit goals for inflation.<sup>5</sup>

<sup>3</sup> Because a negative aggregate supply shock would ordinarily be inflationary and reduce economic activity, a tightening of monetary policy is uncalled for under these circumstances.

<sup>4</sup> Whether underlying inflation rates exclude a significant portion of items from the total CPI varies, of course, across countries. For an illustration in the Canadian and New Zealand cases, see Siklos (1997, Figure A-3). For inflation targeting countries, see Haldane (1995).

<sup>5</sup> Israel also targets inflation but is omitted because of the ambiguity about the significance of its targets (see Bufman, Leiderman, and Sokoler, 1995). In 1998, however, the Bank of Israel began to publish an inflation report. Although not included in this study, the Czech Republic also began targeting inflation in 1998.

target.<sup>8</sup> The five-year horizon is used purely for expository purposes here; the short-run properties of inflation in these same countries are examined in greater detail later in this article. There are many potentially interesting features in the data. First, inflation performance in the inflation-targeting countries appears to have consistently worsened from the early 1970s until the early 1990s than in the countries compared. Second, experience in the mid-1990s reveals an apparent convergence in inflation rates among the group of inflation-targeting and noninflation-targeting countries.<sup>9</sup> Some authors, for example, Cukierman, 1992, and Laidler, 1997, associate the improvement in inflation performance among inflation-targeting countries with legislative changes, which clarified the responsibilities of central banks in the area of monetary policy, and the introduction of inflation-control objectives. Finally, note that during the Bretton Woods era, inflation rates across the group of countries studied were broadly similar. Nevertheless, inflation differentials were somewhat higher at the time than during the 1990s. Note also that the disinflation appears to have begun in Switzerland and Germany shortly after the first oil price shock (1972–74), albeit with some interruption in the early 1980s. The downward trend in inflation rates in the inflation-targeting countries since the late 1970s, however, is fairly continuous. The United States appears to have lagged behind the other countries in experiencing a sustained drop in inflation. Nonetheless, the rate of deceleration appears more pronounced, following the monetary reforms begun in October 1979 under (then) Federal Reserve Chairman Paul Volcker. Finally, we observe that average inflation rates in inflation-targeting countries appear to have fallen before the formal adoption of inflation targets.

Table 2 provides further summary statistics about inflation performance in selected industrial countries. Mean-annualized inflation rates are provided for a sample of quarterly data since the late 1950s or early 1960s, as well as for

subsamples of data from the periods during (and after) Bretton Woods and, where relevant, the era of inflation targeting. As a rough guide to the volatility of inflation in the different samples, the standard deviation also is provided.

Among the group of inflation-targeting countries, mean inflation rates are lower in the period since inflation targets were announced than either before (or since) the end of Bretton Woods. Note, however, that average inflation rates in all sampled countries increased after Bretton Woods was abandoned, though the rise is much more pronounced in some countries (e.g., Australia and the United Kingdom) than in others (e.g., Germany and Switzerland). The improvement in inflation performance is most impressive since inflation targets were introduced, especially when contrasted with the era since exchange rates floated. (The two samples overlap somewhat, of course.) Because other institutional changes also took place around the time inflation targets were announced, it is not clear how much of the reduction in inflation can be attributed to the inflation objectives alone. Moreover, average inflation rates in the United States, Germany, and Switzerland compare favorably with those in inflation-targeting countries during the same period. Therefore, among the group of countries with formal inflation-control objectives, a contributing factor in their success at reducing inflation may be the *global* nature of the recent disinflation. In most countries, inflation volatility rose after the end of Bretton Woods, but generally has been lower since inflation targets were announced. Indeed, inflation volatility in the inflation-control era generally is lower than at any time since the late 1950s.

## INFLATION PERSISTENCE

For some time economists have been interested in estimating how economic shocks will affect the future economy. The effects of such shocks can *persist* over time. The degree to which shocks have persistent effects on inflation, however,

<sup>6</sup> Svensson (1997) argues that inflation forecasts become the intermediate target of policy. Benanke and Woodford (1997) point out, however, that following such a policy is problematic, in part because if the inflation forecast and the target are essentially the same, the inflation forecasting exercise has no practical use.

<sup>7</sup> The inflation targeting countries are listed in Table 1. Poland is henceforth excluded because of insufficient data. A simple unweighted average of their inflation rates was used. Other groupings of the inflation targeting group of countries do not alter fundamentally the overall impressions given by Figure 1.

<sup>8</sup> Perhaps largely for this reason, these countries are, in effect, *perceived* by the public as pursuing an inflation objective.

<sup>9</sup> Siklos and Wohar (1997) provide a more formal assessment of the emergence of convergence in monetary policy for a group of 10 industrial countries and found convergence in the inflation rates but not in the nominal interest rates. Also, see Pollard (1995).

Table 1

## The Basic Ingredients of Inflation Targets

Country/ Index Targeted	Inflation Objective	Calculation Period	Contingencies for Breaches of the Inflation Target	Targeting Horizon?	Adoption date (dd/mm/yy)	Separate Inflation Report?	Who Sets Target?	Publishes Inflation Forecast?
Australia CPI	Average of 2 percent to 3 percent	Over the cycle	Mortgage interest Government-controlled prices Energy prices	None	01/01/93	No <sup>1</sup>	Government	No
Canada CPI <sup>2</sup>	2 percent to 4 percent by end of 1992 1.5 percent to 3.5 percent by mid-1994 (original) (revised) 1 percent to 3 percent Dec 1993 to Feb 2001 <sup>3</sup>	Annual	Indirect taxes Food and energy prices	Yes	26/02/91	Yes	Joint	No
Finland CPI	2 percent from 1995	Annual	Housing capital costs Indirect taxes Government subsidies	No	02/02/93	No <sup>4</sup>	Central bank	No
New Zealand CPI <sup>5</sup>	3 percent to 5 percent (Dec 1990); 2.5 percent to 4.5 percent (Dec 1991) 1.5 percent to 3.5 percent (1992:Q1-Q4) 0 percent to 2 percent (1993:Q1-Q4) 0 percent to 3 percent (1994:Q1-1997:Q1) 0 percent to 3 percent (1997:Q4) <sup>6</sup>	Annual	Commodity prices Government-controlled prices Interest, credit charges	Yes	02/03/90	Yes	Joint	Yes
Poland CPI	8 percent to 8.5 percent in 1999 to below 4 percent percent by 2003	Annual	"...any available information which could jeopardize the inflation target..."	Yes	01/01/99	Yes	Central bank	No
Spain CPI	3.5 percent to 4 percent (1996:Q1) 3 percent to 3.25 percent (1997: Q1) 3 percent upper limit for 1997 2.5 percent to 2.75 percent upper limit for late 1997 2 percent (1998) <sup>7</sup>	Annual	Mortgage interest	Yes	01/01/95	Yes	Central bank	No
Sweden CPI	2 percent 1 percent to 3 percent since 1995	Annual	Nominally none but conditional on indirect taxes, subsidies	No	15/01/93	Yes	Central bank	Yes
United Kingdom RPI	1 percent to 4 percent until June 1997 elections 2.5 percent since June 1997	Annual	Mortgage interest	No	8/10/92	Yes <sup>8</sup>	Government	Yes

<sup>1</sup> The Governor is, however, "available" to report on the conduct of monetary policy twice a year to the House of Representatives Standing Committee on Financial Institutions and Public Administration.

<sup>2</sup> Although the target is formally specified in terms of overall CPI, the Bank focuses on the CPI excluding food, energy, and the effect of indirect taxes. The target represents an agreement between the Minister of Finance and the Governor of the Bank of Canada and is not enshrined in the Bank of Canada Act.

<sup>3</sup> Renewed in February 1998.

<sup>4</sup> Finland reports quarterly on the inflation outlook in its *Monthly Bulletin*.

<sup>5</sup> Since December 1997, the CPI excluding credit services is targeted. Before that date, overall CPI was targeted.

<sup>6</sup> The term of the new PTA coincides with the current term of the Governor, which expires August 31, 2003. The PTAs were agreed to in December but

are dated as beginning the following quarter for compatibility with subsequent empirical work.

<sup>7</sup> The Law of Autonomy was put in place in June 1994 and, although the inflation target was announced in December 1994, it was formally adopted only as of January 1, 1995. Between 1995 and 1997 the aim was to reduce inflation to the 2 percent range. In 1998, the aim is to keep the annual inflation rate "close to 2 percent" during the year.

<sup>8</sup> Only since 12 June 1997

Sources: Siklos (1997), <[www.rbnz.govt.nz/bulletin/contents.htm](http://www.rbnz.govt.nz/bulletin/contents.htm)>, Bank of England Quarterly Bulletin (May 1998), <[www.bof.fi](http://www.bof.fi)>, <[www.bde.es](http://www.bde.es)>, <[www.rba.gov.au](http://www.rba.gov.au)>, Almeida and Goodhart (1998), and National Bank of Poland (1998).

Table 2

Summary Statistics on Inflation for Selected Industrial Countries  
(Quarterly Data)

Country	Annual Inflation Rate in Percent (Standard Deviation)			
	Full sample	Bretton Woods	Post-Bretton Woods	Inflation Targeting
<b>Inflation-Targeting Countries</b>				
Australia	5.60 (4.62)	3.67 (3.32)	6.89 (4.92)	2.01 (2.17)
Canada	4.52 (3.55)	2.48 (2.27)	5.43 (3.65)	1.46 (1.46)
Finland	6.41 (4.91)	5.66 (4.12)	6.74 (5.20)	1.26 (1.59)
New Zealand	6.99 (5.93)	4.53 (3.85)	8.57 (6.48)	2.13 (2.33)
Spain	8.93 (5.89)	7.04 (4.75)	9.77 (6.17)	2.76 (1.35)
Sweden	5.75 (4.45)	4.13 (3.37)	6.73 (4.74)	1.47 (1.86)
United Kingdom	6.48 (6.14)	4.00 (3.98)	7.86 (6.69)	2.64 (2.68)
<b>Non Inflation Targeting Countries</b>				
United States	4.35 (3.23)	2.61 (1.91)	5.30 (3.40)	3.00 (1.50)
Germany	3.04 (2.77)	2.87 (2.80)	3.15 (2.75)	2.35 (2.80)
Switzerland	3.51 (2.92)	3.50 (1.90)	3.52 (3.27)	2.41 (2.32)

Note: CPI inflation is measured at annual rates as  $400 \times (\log CPI_t - \log CPI_{t-1})$ . Data (not seasonally adjusted) are from OECD *Main Economic Indicators: Historical Statistics*, and updated from most recent regular issues of this publication. The United States, Germany, and Switzerland do not officially target inflation so the selection of the "post-inflation target" sample arbitrarily coincides with that of New Zealand. The full sample, before differencing, is generally 1958:1-1997:4, except for Finland and Spain (1963:1-1997:4) and Switzerland (1960:1-1997:4). The dating for the Bretton Woods and inflation-targeting eras is provided in Tables 1 and 3.

can be influenced by assumptions about the properties of the time series of interest, as we shall see. Alogoskoufis and Smith (1991), using long historical time series for the United States and the United Kingdom, argue that changes in the exchange rate regime, such as the end of the gold standard and Bretton Woods, produced significant shifts in inflation persistence. Indeed, inflation appears to have become highly persistent since the end of World War II. Persistence refers to an important statistical property of inflation, namely that its current value is influenced strongly by its past history. If

the data-generating process for inflation is assumed to follow a first-order autoregressive process [AR(1)] then we can write the following equation:

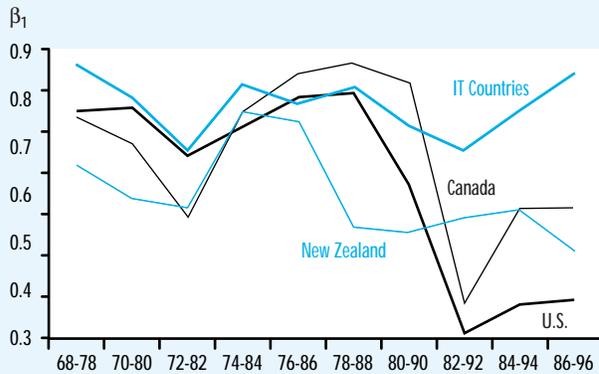
$$(1) \quad \pi_t = \beta_0 + \beta_1 \pi_{t-1} + \varepsilon_t, \quad -1 < \beta_1 < +1$$

where  $\pi_t$  is the annualized rate of inflation in the CPI at time  $t$ ,  $\varepsilon_t$  is the residual and inflation persistence is measured by the coefficient of lagged inflation,  $\beta_1$ .<sup>10</sup> When the AR(1) coefficient is less than but close to one, the process is said to be stationary, but highly persistent. Burdekin and Siklos (forthcoming) use a specification such as

<sup>10</sup>Evaluated as  $\pi_t = (\log P_t - \log P_{t-1}) \times 400$ , where  $P_t$  is the CPI in quarter  $t$  in a given year. Data sources are provided in the tables and figures.

Figure 2

## Inflation Persistence Over Time



NOTE: Estimates of  $\beta_1$  in (1) were estimated for samples of ten years of quarterly data on annualized inflation as defined in Table 2 for the samples shown on the horizontal axis in the Figure. Also see note to Figure 1 for the calculation of average inflation in inflation-targeting countries.

Equation 1. They find that the end of the gold standard produced a significant change in inflation persistence for the United States, the United Kingdom, Canada, and Sweden. They also find that changes in domestic monetary institutions and oil price shocks are equally good indicators of shifts in inflation persistence since the end of World War II. The potential for inflation targeting to change inflation persistence has not heretofore been considered in empirical work.

Why might an inflation target lead to significant changes in  $\beta_1$ ? Consider a simple variant of Equation 1 that helps illustrate the implications of adopting an inflation target.

$$(2) \quad \pi_t = \beta_0 + \beta_1 \pi_{t-1} - \beta_2 I_t \pi_{t-1} + \varepsilon_t, \\ 0 < \beta_2 < 1$$

where  $I_t$  is an indicator that takes on the value of one when last period's inflation rate,  $\pi_{t-1}$ , is above the inflation target and 0 otherwise. Hence, when  $I_t=1$ , the persistence term for inflation is  $\beta_1 - \beta_2$ , which is less than  $\beta_1$ . Now, the monetary authorities are presumed to be solely concerned in Equation 2 with whether actual inflation exceeds the targeted inflation rate. This need not, of course, be the case, but it

does seem to reflect the current practice in most inflation-targeting countries. The issue then is whether the fluctuations around the middle of an inflation-target band would be expected to be asymmetric. Thus, for example, some central banks might follow a policy of benign neglect if actual inflation tends to fluctuate near the bottom of the inflation band while actively preventing inflation from reaching the top of the band. The Bank of England, for one, views the target as symmetric. "The inflation target is symmetric. The MPC (Monetary Policy Committee) will adjust as determinedly in response to prospective deviations of inflation below as those above." (Bank of England, 1998, pg iii.)

Figure 2 provides point estimates of  $\beta_1$  for samples that roll at two-year intervals since 1968. For the most part, inflation rates have been highly persistent, a notable feature of inflation performance in many countries since the end of World War II (also see Alogoskoufis and Smith, 1991, and Burdekin and Siklos, 1999). Nevertheless, since the 1980s, persistence generally has been lowest for the United States and highest for the inflation-targeting group of countries. This result must, however, be tempered by consideration of the New Zealand and Canadian experiences, both of which have had inflation targets in place the longest. Inflation persistence in both these countries have dropped considerably during the 1980s and appear broadly comparable to the current United States experience.<sup>11</sup>

Given the wide variation in inflation performance across countries since the 1960s, it is not clear that the estimates shown in Figure 2 provide a complete picture. Also, it is unclear whether inflation persistence has, for example, been significantly different, in a statistical sense, across the countries considered in Figure 2. In particular, it is not obvious what the effect has been on inflation persistence of, say, changes in exchange rate regimes or the adoption of inflation targets, among other policy shifts that could be considered. Moreover, there are relatively few independent observations in Figure 2

<sup>11</sup>To avoid cluttering Figure 2, Germany and Switzerland are omitted but their experiences broadly parallels that of the United States.

Table 3

Inflation Persistence in Selected Industrial Countries, 1958-97:  
Known Break-Points

Country	Test for Structural Break		Inflation Persistence $\beta_1$			
	Inflation Targeting (1)	Bretton Woods (2)	Full Sample (3)	Bretton Woods (4)	Post-Bretton Woods (5)	Inflation Targeting (6)
<b>Inflation-Targeting Countries (full sample)</b>						
Australia (58:1 - 97:4)	2.14 (.06) <sup>®</sup>	1.65 (.15)	.73 (.06) <sup>®</sup>	.87 (.08) <sup>®</sup>	.67 (.08) <sup>®</sup>	.76 (.17)
Canada (58:1 - 97:4)	3.37 (.01) <sup>+</sup>	7.16 (.00) <sup>+</sup>	.77 (.05) <sup>*</sup>	.17 (.15)	.84 (.05) <sup>*</sup>	.20 (.13)
Finland (63:1 - 97:4)	1.37 (.26)	3.31 (.01) <sup>+</sup>	.72 (.06) <sup>®</sup>	.31 (.15)	.83 (.06) <sup>®</sup>	.22 (.24)
New Zealand (58:1 - 97:4)	1.24 (.29)	2.68 (.02) <sup>*</sup>	.71 (.06) <sup>®</sup>	.41 (.12)	.75 (.07) <sup>®</sup>	.45 (.17)
Spain (63:1 - 97:4)	.71 (.61)	4.75 (.00) <sup>+</sup>	.61 (.07) <sup>®</sup>	.21 (.15)	.73 (.07) <sup>®</sup>	.39 (.26)
Sweden (58:1 - 97:4)	2.89 (.02) <sup>*</sup>	2.78 (.02) <sup>*</sup>	.50 (.07) <sup>®</sup>	.32 (.13)	.51 (.09) <sup>®</sup>	.06 (.13)
United Kingdom (58:1 - 97:4)	1.54 (.18)	2.71 (.02) <sup>*</sup>	.73 (.06) <sup>®</sup>	.42 (.13)	.75 (.07) <sup>®</sup>	-.19 (.25)
<b>Non Inflation-Targeting Countries</b>						
U.S. (58:1 - 97:4)	n.a.	1.17 (.33)	.81 (.05) <sup>*</sup>	.67 (.10) <sup>®</sup>	.80 (0.6) <sup>®</sup>	n.a.
Germany (58:1 - 97:4)	n.a.	3.21 (.01) <sup>+</sup>	.57 (.08) <sup>®</sup>	.33 (.13)	.56 (.08) <sup>®</sup>	n.a.
Switzerland (61:1 - 97:4)	n.a.	.95 (.45)	.55 (.07) <sup>®</sup>	.47 (.14)	.57 (.08) <sup>®</sup>	n.a.

Notes: Estimates are based on Equation 1. Deterministic seasonal dummies were also added (not shown but coefficient estimates are provided in an unpublished appendix). Columns 1 and 2 give the likelihood ratio Chow test statistic (significance level in parenthesis) for a structural break in Equation 1 caused by either the introduction either of an inflation target or the ending of Bretton Woods. The samples are as follows:

	Inflation Targeting	Bretton Woods	
Australia	1993:1	1974:1	Samples shown are before differencing or lags. See Table 1 and Johnson and Siklos (1996) for sources for the above dates. In columns 3 through 6 standard errors are given in parenthesis.  Statistically different from zero: + at the 1 percent level * at the 5 percent level ® at the 10 percent level
Canada	1991:1	1970:2	
Finland	1993:1	1973:1	
New Zealand	1990:1	1973:3	
Spain	1995:1	1973:1	
Sweden	1993:1	1973:1	
United Kingdom	1992:4	1972:2	
United States	n.a.	1972:2	
Germany	n.a.	1973:1	
Switzerland	n.a.	1971:2	

to provide convincing evidence about the persistence question.

Therefore, columns 1 and 2 in Table 3 consider whether the ending of Bretton Woods or the adoption of inflation targets represents structural breaks in Equation 1

in a statistical sense. The relevant Chow tests reveal that for the whole relationship summarized in Equation 1, only Australia, Canada, and Sweden show signs of a statistically significant break in inflation persistence since inflation targeting began.

Inflation persistence appears more consistently affected by the end of Bretton Woods except in the case of Australia, the United States, and Switzerland. A difficulty here is that Chow tests are, strictly speaking, valid only if inflation is stationary. One reason inflation may be viewed conveniently as nonstationary (that is,  $\beta_1=1$ ) is that the econometrician has difficulty identifying the *timing* of structural breaks in the data, and these breaks bias estimates of persistence toward an AR coefficient value of one. A related problem occurs when a change in the behavior of a time series does not coincide with the historical dating of an event. This is perhaps most evident in New Zealand's case where inflation persistence began to drop before inflation targets were formally introduced (see Figure 2).

An additional perspective also can be gained by taking Equation 1 and estimating inflation persistence over specific subsamples. Estimates (and their standard errors) are provided in columns 3 through 6 in Table 3. It immediately is clear that persistence is relatively high in the full sample. This usually is true both for the inflation-targeting and non inflation-targeting countries. All the inflation-targeting countries, with the exception of Australia, show noticeable drops in inflation persistence since inflation targets were adopted.<sup>12</sup> By contrast, inflation persistence usually rose in the post-Bretton-Woods period as a whole. Of course, the chosen subsamples do not exhaust the possible regime changes. Thus, for example, if we reestimate Equation 1 for the subsample following the period of the U.S. Monetary Control Act of 1980, the coefficient of inflation persistence drops to .30 (sample is 1982:1–1997:4 before differencing). A possible drawback with the preceding tests is that they are dependent on the chosen date of the regime change. If expectations are slow to evolve or the announced policy change is not immediately credible, then the timing of the break is not properly estimated. A separate appendix, available on request, presents evidence based on tests where breaks in inflation persistence are endogenously estimated using the

procedures outlined in Burdekin and Siklos (1999) and references therein.

Of course, specifications such as Equation 1 do not measure directly the *credibility* of any announced policy change, especially of the inflation-targeting variety. Figure 3 shows inflation performance in the overall CPI, during the inflation-control era only, relative to stated inflation targets. Although most countries have generally come close to achieving their targets, there have been some breaches of the inflation targets even in countries where a significant shift in inflation persistence has been detected.<sup>13</sup> Perhaps the most celebrated case is that of New Zealand where the inflation target was first breached in 1994. As the Reserve Bank of New Zealand noted at the time, inflation targets should be interpreted as an objective that the central bank

“[would] be constantly aiming, not necessarily a target which could, given the inevitable uncertainties in forecasting and lags in the effectiveness of monetary policy, always be certain of attainment.” (Reserve Bank of New Zealand, 1996, Appendix 2, 42–4, emphasis in original).

Part of the difficulty is that accountability under an inflation target, with potential consequences for credibility, is itself subject to a lag because *actual* inflation is the metric by which success at meeting the desired objective is assessed. Accordingly, as noted earlier, accountability and credibility may require that a central bank do more than demonstrate its success or failure after the fact.

An alternative view of the credibility issue asks whether inflationary expectations changed around the time inflation-targeting policies were introduced. Figure 4 plots average annualized CPI inflation forecasts for inflation-targeting countries around the time inflation-targeting policies were adopted in each country.<sup>14</sup> CPI inflation forecasts for a given year are released on a monthly basis beginning in the preceding year for which the forecast applies. We see

<sup>12</sup>A Wald Test could not reject the null hypothesis that  $\beta_1$  is the same in the inflation-targeting and post-Bretton Woods samples for Australia. The same hypothesis was decisively rejected for New Zealand, the only other country where inflation remains persistent in the inflation-targeting sample.

<sup>13</sup>To be fair, central banks in inflation-targeting countries assess inflation performance in terms of CPI inflation net of supply-side shocks and not inflation in the total CPI. Nevertheless, one of the credibility problems faced by inflation-targeting countries is the potential for conflict or uncertainty stemming from the differential between these two measures of inflation. See Siklos (1997).

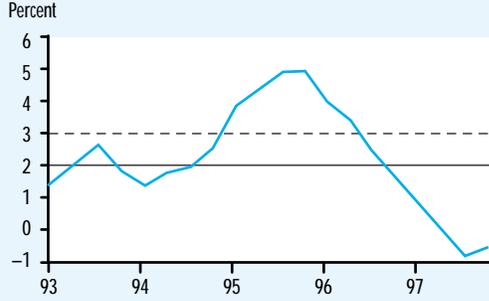
<sup>14</sup>No comparable data for Finland were available. The forecasts, except for New Zealand, are an average of inflation forecasts by large banks across 14 countries surveyed by *The Economist* magazine. Siklos (1997 and 1998) conducts a more extensive analysis of changes in inflation forecasts in inflation-targeting countries.

Figure 3

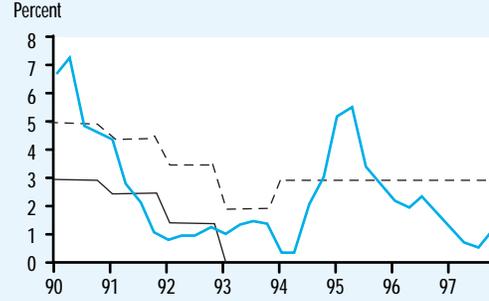
## Inflation and Targets

Quarterly annualized growth rates

### Australia



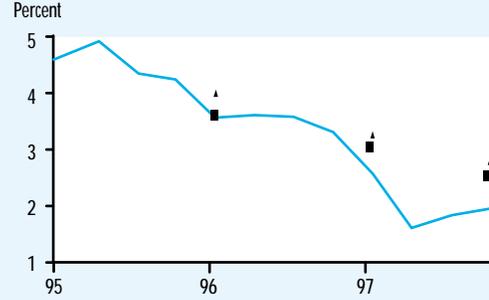
### New Zealand



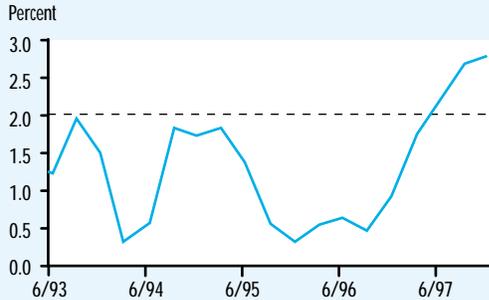
### Canada



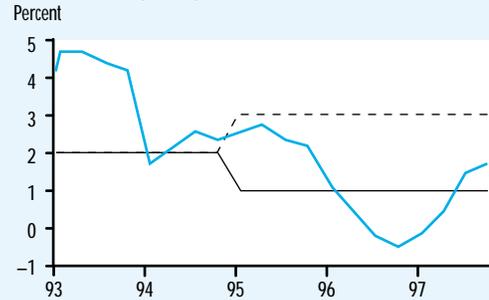
### Spain



### Finland



### Sweden (CPI)



### United Kingdom (RPI)

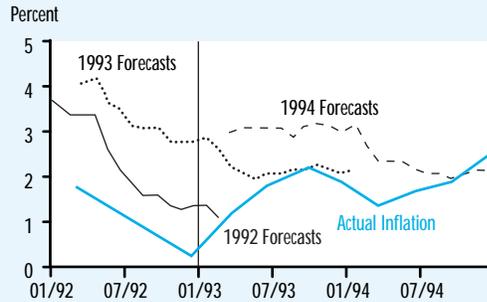


NOTE: The horizontal lines (or symbols, in the case of Spain) represent the inflation targets. See Table 1 details. Inflation rates in the CPI are at annual rates (also see Figure 1).

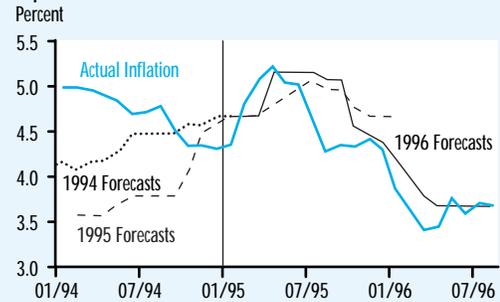
Figure 4

## Inflation and Forecasts Quarterly annualized growth rates

### Australia



### Spain



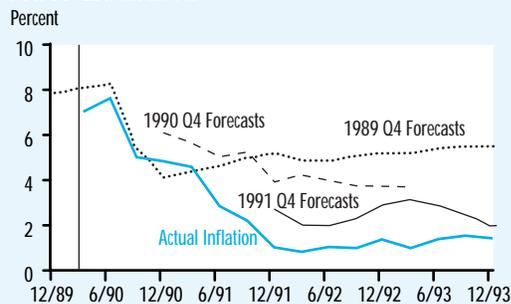
### Canada



### Sweden



### New Zealand



### UK



that in all countries except Australia the announcement of inflation targeting led to a reduction in private-sector expectations of future inflation with a short lag. The effect is more pronounced in some countries (e.g., Canada, New Zealand, Sweden, and the United Kingdom) than in others. It also is interesting to note that inflation forecasts for a given year often are slow to change except perhaps when there

is an announcement, such as the introduction of an inflation-targeting policy. By contrast, forecasts for different years do show signs of changing rather sharply in some cases (e.g., 1992 vs. 1991 inflation forecasts for Canada).<sup>15</sup> Of course, some of the inflation forecasts may not take into account changes in monetary policy [see, for example, Croushore (1996)]. In general, it is difficult to replicate

<sup>15</sup>Indeed, Siklos (1997) reports that inflation forecasts have been more volatile in inflation-targeting countries.

the information sets forecasters use to generate their predictions about the future course of inflation (Siklos, 1998).

The failure of inflation forecasts to adjust more rapidly to the fall in actual inflation—note the persistent differential between actual and forecasted inflation in several of the inflation-targeting countries—may reflect residual uncertainty about whether the monetary and fiscal authorities are committed to the new policy regime. Mitigating this possibility is the fact that the current disinflation appears to be a global phenomenon, as noted earlier. Other evidence, not shown here, relying on estimates of the slope of the yield curve, also suggests that the introduction of targets was, for the most part, credible, (see Siklos, 1998).

## CONCLUSION

This paper has considered whether the adoption of inflation targets has affected the time series properties of inflation, both in relation to the past performance of inflation in countries that have adopted such a policy, and in comparison with the policy record of the United States, Germany, and Switzerland. The latter group of countries are thought to have good inflation performance without having explicitly adopted an inflation target. Also examined was the role played by the design of the inflation target in particular and institutional considerations more generally in accounting for the success of the policy.

Descriptive and econometric evidence suggest that the mere adoption of an inflation target is sufficient neither in delivering consistently better inflation performance nor in significantly influencing inflation expectations. Nevertheless, for a subset of countries, notably Canada, New Zealand, Finland, Spain, Sweden, and the United Kingdom, inflation persistence has dropped significantly after the adoption of inflation targets. Moreover, the adoption of an inflation target in these countries has delivered significantly lower interest rates than would otherwise have been the case. (See Murchison and Siklos, 1999). Despite

the apparent effect of inflation targets and of associated reform to central banking operations, the fact remains that the disinflation of the 1990s is an international phenomenon. It remains to be seen whether inflation targeting can withstand pressures stemming from sustained breaches of targets should inflation policies in the major industrialized countries begin to diverge. Also important is the question whether inflation targets can assist in delivering better long-run economic performance. The early reviews have not been favorable. For a mixture of reviews, see Fortim (1996), Freedman and Macklem (1998), Krugman (1996), and Siklos (1997).

## REFERENCES

- Almeida, Alvaro, and Charles A.E. Goodhart. "Does the Adoption of Inflation Targets Affect Central Bank Behaviour?" *Banca Nazionale del Lavoro Quarterly Review*, Supplement, (March 1998), pp. 19–107.
- Allogoskoufis, George S., and Ron Smith. "The Phillips Curve, the Persistence of Inflation, and the Lucas Critique: Evidence from Exchange-Rate Regimes," *American Economic Review* (December 1991), pp. 1254–75.
- Berg, Claes, and Lars Jonung. "Pioneering Price Level Targeting: The Swedish Experience, 1931-77," paper prepared for the Conference on Monetary Policy Rules, Stockholm, Sweden, June 1998.
- Bernanke, Ben, Thomas Laubach, Frederic S. Mishkin, and Adam S. Posen. *Inflation Targeting: Lessons from the International Experience*, Princeton University Press, 1999.
- Bernanke, Ben S., and Michael Woodford. "Inflation Forecasts and Monetary Policy," National Bureau of Economic Research Working Paper 6157, September 1997.
- Bordo, Michael. "The Bretton Woods International Monetary System: A Historical Overview," *A Retrospective on the Bretton Woods System: Lessons for International Monetary Reform*, Michael D. Bordo and Barry Eichengreen, eds., University of Chicago Press, 1993, pp. 3–98.
- Bufman, Gil, Leonardo Leiderman, and Meir Sokoler. "Israel's Experience with Explicit Inflation Targets: A First Assessment," *Inflation Targets*, Leonardo Leiderman and Lars E.O. Svensson, eds., London: Centre for Economic Policy Research, 1995, pp. 169–91.
- Burdekin, Richard C.K., and Pierre L. Siklos. "Exchange Rate Regimes and Shifts in Inflation Persistence: Does Nothing Else Matter?" *Journal of Money, Credit and Banking*, forthcoming.
- Campbell, John Y., and Pierre Perron. "Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Roots," *NBER Macroeconomics Annual 1991*, Olivier Jean Blanchard and Stanley Fischer, eds., The MIT Press, 1991, pp. 141–200.

- Croushore, Dean. "Inflation Forecasts: How Good Are They?" *Business Review*, Federal Reserve Bank of Philadelphia, May/June 1996 <[www.libertynet.org/fedresrv/econ/br/brmj96dc.html](http://www.libertynet.org/fedresrv/econ/br/brmj96dc.html)>.
- Crow, John. "A Comment," *Where We Go From Here: Inflation Targets in Canada's Monetary Policy Regime*, David E.W. Laidler, ed, C.D. Howe Institute, 1997, pp. 68–75.
- Cukierman, Alex S. *Central Bank Strategy, Credibility and Independence: Theory and Evidence*, The MIT Press, 1992.
- Debelle, Guy. "The Ends of Three Small Inflations: Australia, New Zealand and Canada," *Canadian Public Policy*, March 1996, pp. 56–78.
- Eichengreen, Barry. *Golden Fetters: The Gold Standard and the Great Depression, 1919-1939*, Oxford University Press, 1992.
- European Central Bank. "A Stability-Oriented Monetary Policy Strategy for the ECSB," October 13, 1998 <[www.ecb.int/press/pr981013\\_1.htm](http://www.ecb.int/press/pr981013_1.htm)>.
- Federal Reserve Bank of Kansas City. *Achieving Price Stability*, A Symposium, Jackson Hole, Wyoming, August 29-31, 1996.
- Fortin, Pierre. "The Great Canadian Slump," *Canadian Journal of Economics* (November 1996), pp. 761–87.
- Freedman, Charles, and Tiff Macklem. "A Comment on the Great Canadian Slump," *Canadian Journal of Economics* (August 1998), pp. 646–65.
- Haldane, Andrew G. *Targeting Inflation: A Conference of Central Banks on the Use of Inflation Targets*, organized by the Bank of England, March 9-10, 1995.
- Hatanaka, Michio. *Time-Series-Based Econometrics: Unit Roots and Co-integrations*, Oxford University Press, 1996.
- Johnson, David R., and Pierre L. Siklos. "Political and Economic Determinants of Interest Rate Behavior: Are Central Banks Different?" *Economic Inquiry* (October 1996), pp. 708–29.
- Krugman, Paul. "Stable Prices and Fast Growth: Just Say No," *The Economist* (August 1996).
- Laidler, David E.W., ed. *Where We Go From Here: Inflation Targets in Canada's Monetary Policy Regime*, policy study 29, C.D. Howe Institute, 1997.
- Leiderman, Leonardo, and Lars E.O. Svensson. *Inflation Targets*, Centre for Economic Policy Research, London, 1995.
- Mishkin, Frederic S., and Adam S. Posen. "Inflation Targeting: Lessons from Four Countries," Federal Reserve Bank of New York, *Economic Policy Review* (August 1997), pp. 9–110.
- Murchison, Steven, and Pierre L. Siklos. "Central Bank Reaction Functions, Central Bank Independence and Policy Regimes: International Evidence." (May 1999), Wilfrid Laurier University <[www.wlu.ca/~wwwsbe/faculty/psiklos/papers/cbpanel.wpd](http://www.wlu.ca/~wwwsbe/faculty/psiklos/papers/cbpanel.wpd)>.
- National Bank of Poland. *Medium-Term Strategy of Monetary Policy* (1999-2003), National Bank of Poland, 1998.
- Pollard, Patricia S. "EMU: Will it Fly?" this *Review* (July/August 1995), pp. 3-16.
- Reserve Bank of New Zealand. *Monetary Policy Statement*, June, 1996.
- Siklos, Pierre L. "Charting a Future for the Bank of Canada: Inflation Targets and the Balance Between Autonomy and Accountability," *Where We Go From Here: Inflation Targets in Canada's Monetary Policy Regime*, David E.W. Laidler, ed., C.D. Howe Institute, 1997, pp. 101–84.
- \_\_\_\_\_. "Pitfalls and Opportunities for the Conduct of Monetary Policy in a World of High Frequency Data," *Information in Financial Asset Prices* (May 1998).
- \_\_\_\_\_, and Mark E. Wohar. "Convergence in Interest Rates and Inflation Rates Across Countries and Over Time," *Review of International Economics* (February 1997), pp. 129–41.
- Svensson, Lars E.O. "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review* (June 1997), pp. 1111–46.
- Willett, Thomas D. "International Financial Markets as Sources of Crisis or Discipline: The Too Much, Too Late Hypothesis," unpublished, Claremont Graduate University, 1998.