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Abstract

An increasing number of countries have adopted inflation targeting since New Zealand first adopted this framework in early 1990. Currently there are 21 countries using inflation targeting in every continent of the world. This paper discusses the economic effects of inflation targeting. The main conclusion is that inflation targeting has largely been a success. The new framework has made central banks, which previously lacked credibility, able to change the way they do monetary policy towards what is commonly considered best practice. In many respects they have even been leading in creating a new benchmark for how to formulate monetary policy.

Keywords: Inflation targeting; Monetary policy.

JEL-keys: E42; E52; E58.

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1. Introduction

An increasing number of countries have adopted inflation targeting since New Zealand first adopted the framework in early 1990. Currently there are 21 countries using inflation targeting in every continent of the world. A number of others countries have adopted certain aspects of this new regime and some are currently considering adopting fully-fledged inflation targeting in the next few years. The reason for this increasing popularity is that inflation targeting is thought to combine the two aspects considered important for successful monetary policy, i.e. providing a credible medium-term anchor for inflation expectations but at the same allowing policy enough flexibility to respond to short-run shocks without jeopardising the credibility of the framework.

This paper attempts to measure the economic effects of inflation targeting along several dimensions. In short, the results imply that inflation targeting has largely been a success. Inflation has been brought down, although it has certainly fallen globally. Inflation in the targeting countries is currently similar to that in non-targeting industrial countries which are generally considered to run a successful monetary policy. This must be considered as some achievement since many of the inflation targeting countries had been fighting high inflation for decades before adopting the new regime. These countries have also managed to maintain low inflation more easily than in the past. Fluctuations in inflation have also subsided. These results have not been at the cost of lower growth or increased business cycle variability. The inflation targeting countries have therefore managed to change the way they do monetary policy towards what is commonly considered best practice. In many respects they have even been leading in creating a new benchmark for how to formulate monetary policy.

This paper is organised such that the next section documents the inflation targeting countries sample and the timing of target adoption. The third section analysis the economic effects of inflation targeting on inflation, growth, interest rates and exchange rates. The fourth section concludes.

2. The inflation targeting countries

There are currently 21 countries commonly thought to follow an inflation targeting regime.[1] Table 1 gives a list of these countries, with information on the timing of adoption and the numerical inflation target chosen. A detailed discussion of the country group and the formulation of the regime in each country is given in Pétursson (2004).

Table 1. The inflation targeting countries

Countries	*Start of framework*	*Current target*	*Long-run target*
Australia	April 1993	2-3%	Same as current
Brazil	June 1999	3¼% (±2%)	3¾% (±2½%)
Canada	February 1991	1-3% (2% midpoint)	Same as current
Chile	September 1990	2-4%	Same as current
Columbia	September 1999	5½% (±½%)	3%
Czech Republic	January 1998	2½-4½%	2-4%
Hungary	January 2001	3½% (±1%)	Same as current
Iceland	March 2001	2½% (±1½%)	Same as current
Israel	January 1992	1-3%	Same as current
Korea	April 1998	3% (±1%)	2½-3½%
Mexico	January 1999	3% (±1%)	Same as current
New Zealand	March 1990	1-3%	Same as current
Norway	March 2001	2½% (±1%)	Same as current
Peru	January 2002	2½% (±1%)	Same as current
Philippines	January 2002	4½-5½%	4-5%
Poland	October 1998	3% (±1%)	2½% (±1%)
South Africa	February 2000	3-6%	Same as current
Sweden	January 1993	2% (±1%)	Same as current
Switzerland	January 2000	0-2%	Same as current
Thailand	May 2000	0-3½%	Same as current
United Kingdom	October 1992	2%[1,2]	Same as current

The country group and current inflation targets as of end of year 2003. 1. Formally, the inflation target of the Bank of England also defines a ±1% range. The Bank does not interpret this as a formal range for the target but only as a threshold for the Bank to write an open report to explain if inflation moves outside the range. 2. The target was previously 2½% but was lowered when the priced index of the targeting framework was changed.

Sources: Fracasso et al. (2003), Mishkin and Schmidt-Hebbel (2001), Pétursson (2004), Schaechter et al. (2000), Truman (2003) and central banks homepages.

As discussed in Pétursson (2004), some discrepancy can be found in the exact timing of adoption in some of the countries. The reason is usually that the regime was adopted gradually rather than with a big bang. This makes exact timing of adoption somewhat difficult and different dates can be argued for, based on what features of the

[1] Finland and Spain also adopted an inflation target in the mid 1990s before joining the European Monetary Union in the beginning of 1999.

framework one thinks are necessary for the regime to be defined as formal inflation targeting.

This paper follows Fracasso et al. (2003), which again follow the timing convention in Mishkin and Schmidt-Hebbel (2001), except where some central banks have suggested alternative starting dates (Korea, New Zealand, Peru and Thailand). There are, however, three exceptions. Fracasso et al. (2003) define the starting date of inflation targeting in New Zealand as being April 1988 when a numerical object for inflation was first announced in the New Zealand's Government budget statement. Following Mishkin and Schmidt-Hebbel (2001), this paper defines the starting date as March 1990 when the first Policy Targets Agreement between the Minister of Finance and the Governor of the newly independent Reserve Bank of New Zealand was published, specifying numerical targets for inflation and the dates by which they were to be achieved.[2] The second country is Chile, where this paper follows Truman (2003) and defines the starting date as September 1990, when the Central Bank of Chile first announced an inflation target, rather than January 1991 as in Fracasso et al. (2003) which is the first calendar year of the new regime. Others, such as Schaechter et al. (2000) define the starting date as September 1999 when the crawling exchange rate peg was abolished and a fully-fledged inflation targeting regime finally in place.[3] The third country is Australia. Following Schaechter et al. (2000) the starting date is here defined as April 1993 when the Reserve Bank of Australia announced the adoption of the new framework, rather than September 1994 when an exact numerical target was first announced (cf. Bernanke et al., 1999).

3. Economic effects of inflation targeting

A number of studies on the economic effects of inflation targeting have emerged in recent years as the experience with this new framework has increased and the number

[2] An alternative starting date could be July 1989 when a new act for the Reserve Bank was first introduced (e.g. Schaechter et al., 2000), or December 1989 when the new act was passed through Parliament (Truman, 2003). This example clearly depicts the various issues concerning the exact timing of inflation targeting adoption in some countries.

[3] It is sometimes assumed that the inflation target was adopted at a later date in Israel and Poland, again referring to the adoption of a fully-fledged inflation targeting regime, which was in June 1997 in Israel and March 1999 in Poland. Some authors also define the starting date for Columbia, Mexico, Peru and the Philippines earlier than is done here. They define the starting date as the date the central banks of these countries started declaring numerical inflation objects for one year hence, which was 1994 in Peru and 1995 in Columbia, Mexico and the Philippines.

of countries adopting inflation targeting has expanded.[4] Still, this literature is handicapped by a relatively small number of inflation targeters and by the fact that many of these countries have yet to go through a complete business cycle with the new regime. This especially applies to the emerging market countries in the sample, of which many have only adopted inflation targeting in the last few years. Another problem for empirical studies on inflation targeting is the fact that the new regime was adopted under different economic conditions in each country. These conditions have recently also been quite favourable in most countries, inflation targeters and non-targeters alike. Inflation and interest rates have fallen, growth expanded and fluctuations in inflation and growth subsided. These facts have to be taken into account when studying whether the adoption of inflation targeting can explain some part of these developments.

3.1. Effects on inflation

3.1.1. Average inflation

At first sight one might argue that the appropriate metric for measuring the success of inflation targeting should be the frequency of hitting the official inflation targets over time. Even though the results in Corbo et al. (2001) indicate that the deviations of inflation from target have in general been quite small (although larger in the Eastern European countries Poland and the Czech Republic; see Jonas and Mishkin, 2003), one can argue that looking only at the success of hitting inflation targets gives a too narrow perspective. All the inflation targeting central banks emphasize the flexibility of the framework and that temporary deviations from target should be allowed if the economic situation so demands. The main purpose of the inflation targeting framework is to provide a credible anchor for monetary policy over the medium-term. It is therefore more appropriate to measure the success of inflation targeting by looking at how successful the inflation targeting central banks have been in bringing inflation down to a rate that corresponds to price stability and keeping it close to that level. Indeed, temporary deviations from target do not seem to have seriously damaged the credibility of the banks (see, for example, Schaechter et al., 2000). One explanation is the great effort the banks have put into explaining probable target misses prior to their occurrence.

[4] Recent surveys of these empirical results can be found in Ball and Sheridan (2003), Neuman and von Hagen (2002) and Truman (2003).

Table 2 shows the average inflation in the 21 targeting countries in the last five years prior to target adoption, the last year prior to adoption and after adoption. Also shown is average inflation in the 1980s and 1990s. For comparison, the table reports average inflation in six non-targeting industrial countries (Denmark, France, Germany, Italy, Japan and the US).

Table 2. Inflation prior to and after inflation targeting

Countries	*Average inflation the 5 years prior to adoption*	*Average inflation the year prior to adoption*	*Average inflation after adoption*	*Inflation 2002*	*Average inflation 1981-90*	*Average inflation 1991-02*
Australia	5.0	0.9	2.6	3.0	8.1	2.5
Brazil	462.2	2.6	7.1	8.4	699.8	507.4
Canada	4.5	4.8	2.1	2.4	6.0	2.1
Chile	19.6	22.3	9.2	2.5	20.5	8.4
Columbia	19.2	14.8	8.0	6.4	23.8	17.9
Czech Republic	10.6	9.3	4.7	1.8	–	10.6
Hungary	14.3	9.9	6.8	5.3	10.9	18.2
Iceland	2.8	5.1	5.8	4.9	35.0	3.6
Israel	18.5	19.0	7.7	5.7	121.0	8.6
Korea	5.2	5.7	3.2	3.0	6.3	4.8
Mexico	22.8	16.1	9.2	5.0	69.8	16.5
New Zealand	11.3	5.7	2.2	2.7	10.8	1.9
Norway	2.3	3.1	2.2	1.4	7.6	2.3
Peru	5.0	2.0	0.2	0.2	1,061.7	200.7
Philippines	6.6	6.0	3.1	3.1	14.8	8.1
Poland	22.9	12.8	6.4	1.9	129.3	24.5
South Africa	7.3	5.0	6.9	9.4	14.7	8.7
Sweden	6.9	2.3	1.6	2.2	7.6	2.3
Switzerland	0.8	0.9	1.1	0.7	3.4	1.8
Thailand	4.9	-0.1	1.3	0.7	4.4	4.0
United Kingdom	6.4	4.0	2.5	1.7	6.6	2.8
All countries	31.4	7.2	4.5	3.4	113.1	40.8
Except hyperinflation[1]	8.9	6.8	4.3	3.3	15.6	6.9
Industrial countries[2]	5.0	3.3	2.5	2.4	10.6	2.4
IT-6 group[3]	9.0	6.7	3.4	2.4	9.9	3.3
Non-inflation targeting industrial countries[4]	–	–	–	1.5	5.2	2.1

Quarterly data for the period 1981:1-2002:4 (except for the Czech Republic, were the data start in 1990:4). The table reports periodic averages for percentage changes in the consumer price index from the previous year's quarter. 1. The country group except Brazil, Israel, Peru and Poland. 2. Australia, Canada, Iceland, New Zealand, Norway, Sweden, Switzerland and the UK. 3. Australia, Canada, Chile, New Zealand, Sweden and the UK. 4. Denmark, Germany, France, Italy, Japan and the US.

Sources: EcoWin, IFS, central bank homepages and Central Bank of Iceland, Economics Department.

Inflation has clearly fallen on average after the adoption of inflation targeting when looking at all the targeting countries. Inflation went from over 30% in the last five years prior to adoption to roughly 4½% after inflation targeting. Included in this comparison is, however, inflation in the four former hyperinflation countries, Brazil,

Israel, Peru and Poland. When these four countries are excluded, average inflation in the five years prior to targeting is just under 9% but, again, roughly 4½% after. The table also compares inflation in a group of six countries with the longest history of inflation targeting, again excluding Israel due to its hyperinflation past (the IT-6 group). All these countries have over a ten year experience with inflation targeting (Australia, Canada, Chile, New Zealand, Sweden and the UK). Again the same picture emerges, with inflation falling from 9% to 3½%. Finally, the table shows inflation in the eight industrial countries in the sample. In the five years before targeting inflation was on average about 5%, but falls to 2½% after adoption.

Inflation has therefore clearly fallen on average after the adoption of inflation targeting. Average inflation in the year prior to adoption, however, suggests that this disinflation process had already started before the adoption of inflation targeting. Hence, inflation targeting may have been more important in locking in the disinflation that had already been achieved than to bring down inflation (cf. Bernanke et al., 1999, and Corbo et al., 2001). This, however, seems to apply more to the industrial countries in the group than the emerging market countries.[5] Two-thirds of the 2½% fall in inflation in the industrial countries had already been accomplished in the year before adoption, whereas only one-third of the 6½% fall in inflation in the emerging market countries (excluding the four former hyperinflation countries).

Comparing average inflation after inflation targeting with average inflation the five years prior to adoption suggests that inflation targeting has contributed to bringing down inflation, especially in the emerging market countries of which many had been fighting high inflation for decades. It is, however, not clear whether this fall in inflation can be directly attributed to inflation targeting. Central bank legislation has, for example, been altered and the emphasis on price stability strengthened, with increased understanding of the importance of low and stable inflation for general economic welfare (see, for example, Pétursson, 2004). Adoption of inflation targeting can be interpreted as one type of manifestation of these developments. This can be seen from Table 2 when comparing inflation in targeting and non-targeting industrial countries. Inflation fell from more than 5% in the 1980s to roughly 2% in the 1990s in

[5] Iceland is in fact the only industrial country where inflation rose in the run up to the adoption of inflation targeting. The inflation targeting regime seems therefore to have served the purpose of turning around the build-up of inflation rather than to lock in low inflation as in most other inflation targeting industrial countries.

the non-targeting group. At the same time inflation fell from 10½% to 2½% in the targeting industrial countries.

As it is not clear whether falling inflation in inflation targeting countries can be related to the adoption of inflation targeting or whether this is simply a global phenomenon, a formal statistical analysis is needed. To do that the following panel model is estimated for the sample of *N* inflation targeting countries

$$(1) \qquad \pi_{it} = \alpha_{\pi i} + \beta_{\pi} IT_{it} + \gamma_{\pi} \pi_{it-1} + \mu_{\pi} y_{it-1} + \lambda_{\pi 0} \pi_t^w + \lambda_{\pi 1} \pi_{t-1}^w + \varepsilon_{\pi it}; \qquad i = 1,...,N; t = 1,...,T$$

where π_{it} is inflation in inflation targeting country *i* at time *t*, y_{it} is output growth in inflation targeting country *i* at time *t* which captures the effects of the domestic business cycle on inflation in each country, π_t^w is the average inflation in six non-targeting industrial countries (Denmark, France, Germany, Italy, Japan and the US), capturing the effects of the global disinflation trend and IT_{it} is a dummy variable which equals one from the first quarter after the adoption of inflation targeting and zero otherwise. The model also includes lagged own inflation to account for a possible bias due to potential correlation between the dummy variable and past inflation performance, i.e. if high inflation countries are more likely to adopt inflation targeting.

The model is estimated as a seemingly unrelated regression (SUR) with fixed country effects for the period 1981:1-2002:4, using different country samples. The first country sample includes all the 21 inflation targeting countries. The second sample includes the 13 countries that had adopted inflation targeting prior to 2000. The third sample includes the 7 countries that had adopted inflation targeting prior to 1999 and had inflation on average below 25% in the 1980s. The fourth sample includes the 6 countries that had adopted inflation targeting prior to 1999 and had inflation on average below 15% in the 1980s. The final sample includes the 5 industrial countries that had adopted inflation targeting prior to 1999.

The main results are reported in Table 3. The effects of inflation targeting are generally found to be statistically significant from zero, even after accounting for the global disinflation trend and domestic business cycle developments (both effects have the expected signs and are found to be statistically significant from zero). According to the estimates in (1), inflation targeting leads on average to a 2½ to more than 3 percentage fall in inflation, depending on which country sample is used, and the

hypothesis that the effect is equal in all countries is not rejected. The effects of inflation targeting on inflation are, however, not found to be significant in the final country sample of five industrial countries with the longest inflation targeting history. This is probably explained by the fact that these countries had already accomplished about three-quarters of the convergence towards price stability before target adoption. The inflation target in these countries more served the role of locking in the disinflation already achieved, as discussed before.

Table 3. Estimation of the effects of inflation targeting on inflation
Estimates from equation (1)

	All countries	*Adoption prior to 2000*	*Adoption prior to 1999 and average inflation 1981-90 below 25%*	*Adoption prior to 1999 and average inflation 1981-90 below 15%*	*Industrial countries and adoption prior to 1999*
β_π	-0.075	-0.213	-0.337	-0.249	-0.150
	(0.053)	(0.085)	(0.099)	(0.102)	(0.106)
$\beta_\pi/(1-\gamma_\pi)$	-1.077	-2.353	-3.326	-3.030	-2.207
	(0.769)	(0.928)	(1.002)	(1.241)	(1.496)
Number of countries	21	13	7	6	5
Number of observations	1,777	1,082	600	513	426
R^2	0.721	0.786	0.935	0.916	0.923
Wald test (*p*-value)	0.528	0.054	0.141	0.179	0.205

The first country group includes all the 21 inflation targeting countries. The second group includes the 13 countries that had adopted inflation targeting prior to 2000 (Australia, Brazil, Canada, Chile, Columbia, Czech Republic, Israel, Korea, Mexico, New Zealand, Poland, Sweden and the UK). The third group includes the 7 countries that had adopted inflation targeting prior to 1999 and had inflation on average below 25% in the 1980s (Australia, Canada, Chile, Korea, New Zealand, Sweden and the UK). The fourth group includes the 6 countries that had adopted inflation targeting prior to 1999 and had inflation on average below 15% in the 1980s (Australia, Canada, Korea, New Zealand, Sweden and the UK). The fifth group includes the 5 industrial countries that had adopted inflation targeting prior to 1999 (Australia, Canada, New Zealand, Sweden and the UK). β_π measures the impact effect of inflation targeting. $\beta_\pi/(1-\gamma_\pi)$ measures the long-run effect of inflation targeting. Numbers in parenthesis are standard errors with standard errors on the long-run effect obtained using the delta method (see Table 14 for details). The estimation period is 1981:1-2002:4 (T = 87). Information on the data and the countries for which data for the whole period was not available can be found in Tables 2 and 8. The Wald test tests the hypothesis that the inflation targeting impact was equal in all the countries ($\beta_{\pi i} = \beta_\pi$, $i = 1, ..., N$). The table reports *p*-values.

An alternative estimation approach is to include the non-inflation target countries in the sample group and to approximate the global disinflation trend with a time trend polynomial, $\lambda_\pi(t)$. In this case the inflation target countries can be thought of as the "treatment group" and the non-inflation target countries as the "non-treatment group". Hence, equation (1) is re-estimated with the trend polynomial replacing π_t^w and with the six non-inflation target countries and the two former inflation target countries, Finland and Spain, included in the country sample (in total

29 countries).[6] For the former six, the inflation target dummy takes the value zero for the whole period, but for the latter two the variable takes the value unity one quarter after the start of the targeting framework until 1999 and zero otherwise

$$(1') \qquad \pi_{it} = \alpha_{\pi i} + \beta_\pi IT_{it} + \gamma_\pi \pi_{it-1} + \mu_\pi y_{it-1} + \lambda_\pi(t) + \varepsilon_{\pi it}; \qquad i = 1,\ldots,N+M; t = 1,\ldots,T$$

where the country sample includes N inflation targeting countries and a control group of $M - N$ countries. The disinflation trend is approximated with a second-order polynomial, $\lambda_\pi(t) = \lambda_{\pi 1} t + \lambda_{\pi 2} t^2$. Table 4 reports the results.[7]

Table 4. Estimation of the effects of inflation targeting on inflation
Estimates from equation (1')

	All countries	*Adoption prior to 2000*	*Adoption prior to 1999 and average inflation 1981-90 below 25%*	*Adoption prior to 1999 and average inflation 1981-90 below 15%*	*Industrial countries and adoption prior to 1999*
β_π	-0.096	-0.146	-0.153	-0.130	-0.117
	(0.041)	(0.054)	(0.059)	(0.061)	(0.062)
$\beta_\pi/(1-\gamma_\pi)$	-1.332	-1.922	-2.127	-1.909	-1.916
	(0.564)	(0.711)	(0.849)	(0.922)	(1.047)
Number of countries	29	21	15	14	13
Number of observations	2,473	1,778	1,296	1,209	1,122
R^2	0.723	0.788	0.948	0.916	0.952

The inflation targeting country groups are defined in Table 3. Also included in all country samples are the two former inflation targeting countries, Finland and Spain, and six non-inflation targeting countries, Denmark, France, Germany, Italy, Japan and the US. β_π measures the impact effect of inflation targeting. $\beta_\pi/(1-\gamma_\pi)$ measures the long-run effect of inflation targeting. Numbers in parenthesis are standard errors with standard errors on the long-run effect obtained using the delta method (see Table 14 for details). The estimation period is 1981:1-2002:4 (T = 87). Information on the data and the countries for which data for the whole period was not available can be found in Tables 2 and 8.

The average long-run effect is now found to be around 2 percentage points instead of up to 3 percentage points in equation (1). The effects are significant in all the country samples, even in the sample including all the 29 countries. Again, the least significant effects are found in the sample only including the five industrial inflation targeting countries with the longest targeting history, although the effects are now only marginally significant at the 5% critical level.[8]

[6] Following Mishkin and Schmidt-Hebbel (2001), the inflation target is assumed to start in February 1993 in Finland and in November 1994 in Spain. Both end in January 1999.

[7] A Wald test for equality of the inflation targeting impact across all the countries cannot be performed in this case as the targeting dummy equals zero throughout for the non-targeting countries.

[8] Alternative estimation periods were also tried, both by starting later to reduce the near unit root properties in the data and by finishing earlier so that some countries in the treatment group became non-treated. The finding of a significant inflation targeting effect remained robust and in some cases a

The results therefore suggest that the adoption of inflation targeting led to a significant reduction in average inflation in the region of 2 to 3 percentage points on average, even after taken account of the global disinflation trend and domestic business cycle developments. These findings are similar to the findings of many other studies, such as Haldane (1995), Bernanke et al. (1999), Corbo et al. (2001), Neumann and von Hagen (2002) and Truman (2003).[9] Ball and Sheridan (2003) are, however, more sceptical and argue that the adoption of inflation targeting played no significant role in bringing inflation down in these countries. They argue that the main reason for earlier support for the importance of inflation targeting for bringing down inflation lies in the simple fact that the targeting countries usually had higher inflation than other similar countries (especially industrial countries) prior to adoption. The observed reduction in inflation towards other industrial countries, such as Germany and the US, can therefore be explained by a simple regression to mean. Inflation in countries with high inflation is likely to fall faster than in countries with low inflation, irrespective of whether they have adopted inflation targeting or not.[10]

If this argument is correct, one should expect the inflation targeting dummy variable to depend on historical inflation, i.e. countries with high inflation in the past are more likely to adopt inflation targeting than countries with low inflation.[11] It is therefore necessary to correct for this potential bias by adding historical inflation to the panel regressions. When Ball and Sheridan (2003) do that, the beneficial effect of inflation targeting is no longer statistically significant which leads them to the above conclusion. This is also done here by adding lagged inflation to the regressions but the effect of inflation targeting remains significant, except in the sample of five industrial countries with the longest experience of the framework, i.e. Australia, Canada, New Zealand, Sweden and the UK, where the effects are either marginally significant or insignificant from zero. In the other country groups the effect remains significant. This is important as the Ball and Sheridan (2003) inflation targeting country sample only covers these five countries (plus Finland and Spain) but does not cover emerging

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larger effect was found than reported here. The effect also remained significant when allowing for a country specific disinflation trend and lagged inflation.

[9] The fall in inflation explained by the adoption of inflation targeting is roughly the same as in Truman (2003), although he uses somewhat different estimation methods.

[10] Truman (2003) points out that the adoption of inflation targeting could have speeded up the adjustment towards low inflation.

[11] The findings in Truman (2003) do, however, suggest that this is not obvious. In fact his findings suggest the opposite: the choice of inflation targeting seems to be negatively associated with past inflation.

market countries, such as Chile, Israel and Korea. As discussed previously, the industrial countries had already accomplished a substantial part of the disinflation process before adopting inflation targeting. Thus, the generalisation made by Ball and Sheridan (2003) that the adoption of inflation targeting did not matter may not hold when one looks outside the narrow group of industrial countries. Truman (2003) also attempts to control for this potential bias, although in a different way than done here, and still finds significant effects of inflation targeting on average inflation.

3.1.2. Fluctuations in inflation

It is also important that inflation targeting contributes to reduce fluctuations in inflation, as pointed out by Jonas and Mishkin (2003). Table 5 compares fluctuations in inflation before and after inflation targeting (using standard deviations). It is clear that fluctuations in inflation have decreased after inflation targeting. This should not be surprising considering the reduction in inflation, given the close relationship between fluctuations in inflation and the level of inflation. The table shows that fluctuations in non-targeting industrial countries have also fallen.[12]

This might suggest that inflation targeting has contributed to stabilising inflation (see also Neumann and von Hagen, 2002). The results from Johnson (2002) and Truman (2003), however, suggest that inflation targeting has not contributed to decreasing inflation volatility beyond the effect through the inflation level. The results from Corbo et al. (2001), however, suggest that inflation targeting has reduced inflation uncertainty and inflation forecast errors.

Finally, it is interesting that even though fluctuations in inflation have fallen, they are still larger on average than the range of the inflation target commonly used, which is ±1% on average (see Pétursson, 2004). The danger is that trying to cover a large part of the probability distribution of inflation within the target range might hurt the credibility of the regime and reduce its transparency (see also Haldane and Salmon, 1995). A narrower target range has always been chosen, on the basis that inflation fluctuations will be smaller in the future than suggested by historical experience. As discussed in Pétursson (2004), the inflation targeting central banks have decided to tackle the inevitable control problem that arises using alternative

[12] This reduction in inflation variability could influence the previous statistical inference which implicitly assumes constant variability throughout the sample period. The direction of this influence is, however, difficult to predict. The uncertainty in coefficient estimates could be underestimated, but the information in the low variability period could be swamped by the volatility of the earlier period, thus underestimating the statistical significance of the inflation targeting effect.

methods, such as longer target horizons corresponding to the transmission lags of monetary policy, by defining escape clauses ex ante, and by specifying reactions to large deviations from target using, e.g., open letters.

Table 5. Fluctuations in inflation prior to and after inflation targeting

Countries	*Average fluctuations the 5 years prior to adoption*	*Average fluctuations after adoption*	*Average fluctuations 1981-1990*	*Average fluctuations 1991-2002*
Australia	3.0	1.7	2.2	1.7
Brazil	1,165.4	1.6	1,273.4	957.3
Canada	0.5	1.4	3.0	1.4
Chile	5.2	6.8	6.9	5.8
Columbia	3.0	1.3	4.5	7.6
Czech Republic	3.4	3.5	–	10.0
Hungary	4.9	2.2	7.3	8.7
Iceland	1.5	2.5	20.2	2.3
Israel	2.1	4.4	130.0	5.2
Korea	1.2	2.1	5.6	2.3
Mexico	13.0	4.7	41.7	10.9
New Zealand	5.2	1.6	5.1	1.2
Norway	0.7	1.2	2.9	0.8
Peru	2.7	1.0	2,198.9	889.4
Philippines	2.2	0.4	14.5	4.0
Poland	8.5	3.3	264.7	21.5
South Africa	2.2	2.7	2.2	3.4
Sweden	3.0	1.4	2.5	2.5
Switzerland	0.7	0.5	1.9	1.7
Thailand	3.2	0.7	3.3	2.6
United Kingdom	2.3	0.8	2.7	1.3
All countries	58.7	2.2	199.7	92.5
Except hyperinflation	3.2	2.1	7.9	4.0
Industrial countries	2.1	1.4	5.1	1.6
IT-6 group	3.2	2.3	3.7	2.3
Non-inflation targeting industrial countries	–	–	2.9	1.0

Quarterly standard deviation of percentage changes in the consumer price index from the previous year's quarter for the period 1981:1-2002:4. Information on the data and the country groups can be found in Table 2.

Sources: EcoWin, IFS, central bank homepages and the Central Bank of Iceland, Economics Department.

3.1.3. Inflation persistence

Kuttner and Posen (1999) show that temporary price shocks should have less persistent effects on inflation if the formulation of monetary policy changes after the adoption of inflation targeting in such a way that the emphasis on fighting inflation increases. Reduced inflation persistence would also indicate that the credibility of monetary policy has increased and that inflation expectations are more forward looking after the introduction of inflation targeting.

To analyse whether inflation targeting has affected inflation persistence a univariate AR(2) model is estimated (both autoregressive lags are found significant in all cases)

$$(2) \qquad \pi_{it} = \alpha_i + \phi_1 \pi_{it-1} + \phi_2 \pi_{it-2} + \theta IT_{it} \pi_{it-1} + \lambda(t) + \xi_{it}; \qquad i = 1,..., N+M; t = 1,..., T$$

The model also includes the trend polynomial, $\lambda(t)$, to capture the effects of slowly falling average inflation. The memory of the inflation process is given by $\phi_1 + \phi_2$ prior to targeting and by $\phi_1 + \phi_2 + \theta$ after targeting. A significantly negative θ would therefore suggest that inflation persistence had fallen so that the durability of the effects of temporary price shocks on inflation had decreased.[13]

Table 6. Estimation of effects of inflation targeting on inflation persistence (θ)

	All countries	*Adoption prior to 2000*	*Adoption prior to 1999 and average inflation 1981-90 below 25%*	*Adoption prior to 1999 and average inflation 1981-90 below 15%*	*Industrial countries and adoption prior to 1999*
			Sample period 1981-2002		
Estimates of θ	-0.076	-0.087	-0.083	-0.082	-0.067
	(0.011)	(0.014)	(0.016)	(0.019)	(0.021)
			Sample period 1990-2002		
Estimates of θ	-0.055	-0.050	-0.020	-0.063	-0.051
	(0.006)	(0.009)	(0.011)	(0.016)	(0.017)

Standard errors are given in parenthesis. The inflation targeting country groups are defined in Table 3. Also included are the two former inflation targeting countries, Finland and Spain, and six non-inflation targeting countries, Denmark, France, Germany, Italy, Japan and the US. The estimation period is 1981:1-2002:4 (T = 87). Information on the data and the countries for which data for the whole period was not available can be found in Table 2.

The estimation of θ is given in Table 6. The coefficient is found to be significantly negative in all cases, suggesting that inflation targeting has reduced inflation persistence. Due to the near unit root properties of the inflation data for the whole period one should, however, be careful in interpreting these results. In an attempt to reduce this problem, the model is re-estimated for a shorter period from 1990, where the autoregressive roots are somewhat smaller and further away from unity. The estimates of θ are found to be smaller but still remain statistically significant below zero in all country samples.

[13] The autocorrelation coefficients of the inflation process are given as $\rho_1 = (\phi_1 + \theta IT)/(1-\phi_2)$, $\rho_2 = (\phi_1 + \theta IT)^2/(1-\phi_2) + \phi_2$ and $\rho_k = (\phi_1 + \theta IT)\rho_{k-1} + \phi_2 \rho_{k-2}$, k = 3, 4, ... The coefficients are therefore lower after the adoption of inflation targeting (i.e. when IT = 1) if $\theta < 0$. It did not matter which lag the dummy variable was imposed on.

It is also interesting that the effect is found significant in the industrial country group, where an effect of inflation targeting on average inflation was not found previously. As discussed before, the main role of the target in this group was to lock in the disinflation already achieved rather than to facilitate disinflation. These countries had already accomplished a significant share of the disinflation process prior to adopting inflation. Even so, significant effects of inflation targeting on inflation persistence remains.[14]

These results are consistent with the findings in Siklos (1999), Bernanke et al. (1999) and Corbo et al. (2001). They also suggest that the properties of the inflation process in the inflation targeting countries are now much more in line with non-targeting countries with a long history of credible monetary policy, such as Germany and the US.

3.1.4. Speed of convergence to the long-run target

An important issue for countries adopting inflation targeting when inflation is above the long-run target consistent with price stability, is to decide the speed of convergence towards the long-run target. Disinflating too fast might incur temporary losses in output and jobs which could harm the support for the disinflation program and the independence of the central bank, as suggested by the experience of the Czech Republic and Poland (see Jonas and Mishkin, 2003). Too slow convergence towards price stability risks, however, that inflation expectations get stuck at a higher level of inflation which would make further disinflation all the more difficult. This especially applies if initial credibility of the regime is low. Investing in increased credibility with tight policy early on might in that case be sensible, which could allow for more flexibility later. Tightening too much, however, risks the loss of public support as mentioned before.

Theoretically, one can argue that there exists an optimal speed of convergence which minimises the sacrifice ratio (see, for example, Jonas and Mishkin, 2003). The determination of this optimal speed of disinflation is, however, a complicated problem with the level affected by a number of factors such as the underlying shocks driving the disinflation process, institutional factors such as country openness to trade and

[14] In some cases these results remain sensitive to the exact choice of sample period, suggesting that some care in the interpretation of the results are in order.

labour market centralisation, and the degree of public support for the disinflation program.

It is common for countries in a disinflation phase to specify short-run inflation targets, usually for one year ahead. In these cases the question often arises how to respond if inflation falls below the short-run target but remains above the long-run target consistent with price stability, cf. the experience in the Czech Republic and Poland. The central bank might take the short-run target literally and cut interest rates to push inflation back up to the annual target, although attaining such short-run targets is notoriously difficult given the transmission lags of monetary policy. An alternative approach would be opportunistic disinflation, were the unexpected fall in inflation is locked in, as was the case with the above mentioned countries. This implies that the inflation targeting regime is asymmetric in the convergence period, i.e. the central bank fights inflation above the short-run target but welcomes inflation below it.

The main argument for such an asymmetric approach is the lack of credibility at the announcement of the new framework. When inflation is relatively high, the central bank runs the risk of serious damage to credibility if he cannot avoid inflation moving above the target. Opportunistic disinflation, however, gives rise to an alternative problem, as pointed out by Jonas and Mishkin (2003). The risk is that the targeting regime might lose the support of politicians and the public in general, especially if disinflation is accompanied by an economic contraction as was the case in Poland. It might also be risky to try to lock in unexpected disinflation resulting from temporary external shocks, such as terms of trade shocks, as considerable costs to the real economy might ensue any attempt to prevent inflation from rising again when the shock is reversed. It is therefore clear that monetary policy can go too far in attempting to lock in unexpected disinflation in the adjustment process towards the long-run target. It is also clear that as soon as the long-run target is achieved, the argument for the asymmetric treatment of the target no longer holds. The symmetric treatment of the inflation target is in fact one of the important benefits of the regime. In that way the central bank credibly signals its intention to avoid deflation, with the symmetric treatment also contributing to increased stability of the real economy.

Table 7. Speed of convergence towards long-run inflation target

Countries	*Midpoint of Inflation target*[1]	*Initial Inflation*[3]	*Speed of convergence (quarters)*[4]	*Estimated speed of convergence (quarters)*[7]
Australia	2.5	1.2	0	0
Brazil	3.75	2.3	0[5]	0
Canada	2.0	5.3	5	5
Chile	3.0	24.6	37	34
Columbia	3.0	9.6	14[6]	10
Czech Republic	3.0	10.2	5	11
Hungary	3.5	10.3	8	11
Iceland	2.5	4.2	8	3
Israel	2.0	18.5	32	26
Korea	3.0	9.0	4	9
Mexico	3.0	18.0	16[6]	23
New Zealand	2.0	7.2	7	8
Norway	2.5	3.1	3	1
Peru	2.5	0.2	0	0
Philippines	4.5	4.4	0	0
Poland	2.5	11.1	15	14
South Africa	4.5	2.1	0[5]	0
Sweden	2.0	2.2	0	0
Switzerland	1.0	1.5	0	1
Thailand	1.75	1.0	0	0
United Kingdom	2.5[2]	3.6	1	2
All countries	2.7	7.1	7	8
Except hyperinflation	2.7	6.9	6	7
Industrial countries	2.1	3.5	3	2
IT-6 group	2.3	7.3	8	8

1. Long-run inflation target or midpoint of target range from Table 1. 2. The table does not report the newly adopted 2% target for Bank of England as this change only occurred in December 2003 and is based on a different price index from the one used here. 3. Annual inflation in the quarter prior to adoption of inflation targeting. 4. Number of quarters until inflation is less than ½ percentage point from the long-run target. 5. Inflation rose somewhat above the target later on. 6. The adjustment process was not finalised by the end of 2003. 7. The speed of adjustment regressed on the absolute difference between initial inflation and the long-run target, for a cross section of the 21 countries (White heteroscedasticity-consistent standard error in parenthesis):

$$C = \underset{(0.144)}{1.568}|\pi - \pi^T|; \qquad R^2 = 0.895,\ s = 3.38$$

where C is the speed of convergence in quarters, π is the initial inflation and π^T is the midpoint of the long-run inflation target. Information on the country groups can be found in Table 2.

Sources: Table 1, EcoWin, IFS and Central Bank of Iceland, Economics Department.

Table 7 shows the speed of convergence towards the long-run inflation target in the 21 inflation targeting countries. Defining price stability as inflation less than ½ a percentage point above the long-run target in the quarter before adoption (hence, the inflation target at the beginning of the framework is not used), gives eight countries which had already achieved price stability before adopting the new regime.[15] In

[15] Included are five countries where inflation was already below the long-run target at the start of the regime. The adjustment process is considered as complete in these countries, even though inflation was

addition, the UK accomplished its convergence in one quarter and Norway falls just outside the upper limit of the definition of completing the process (inflation 0.6 percent above the criteria). Of these eight countries, two of them (Brazil and South Africa) have subsequently run into problems with inflation rising considerably above target.[16]

The long-run inflation target has been reached in seven quarters on average for the whole country sample but only in three quarters in the industrial countries, reflecting the fact that inflation was much lower in the industrial countries than in other targeting countries at the start of the regime, as discussed before. Not surprisingly, given its high initial inflation, the longest transition period is found in Chile and Israel. According to the above definition of price stability, the transition process was not yet accomplished in Columbia and Mexico by the end of 2003.

There is a close relationship between the speed of convergence and the distance of initial inflation from the long-run target. On average it takes roughly 1½ quarter to reduce the distance by one percentage point. This suggests that the speed of convergence was shorter than might be inferred from the distance of initial inflation from the long-run target in the Czech Republic and Korea, but longer in Columbia, Iceland and Israel.[17]

3.2. Effects on growth and business cycle variability

3.2.1. Effects on average growth

Some of those sceptical about the usefulness of inflation targeting worry that the regime is too rigid and may therefore hinder the central bank in paying sufficient attention to real economy developments. They fear that inflation targeting may therefore be harmful for growth, at least temporary (see, for example, Friedman and

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more than ½ a percent below the target. The results do not materially change when these deviations are also taken account of.

[16] The reason for increasing inflation in Brazil can be explained by the increasing accumulation of government debt and the loss of credibility that followed, which led to a large depreciation of the real. The reason for increasing inflation in South Africa can also be traced to a depreciation of the rand. Inflation has fallen recently in both countries and both central banks expect inflation to fall into line in the near future (cf. the latest Inflation Reports).

[17] It is interesting to note that the adjustment towards the inflation target in Iceland took a somewhat longer time than suggested by the average speed of adjustment in the country group since the Bank was heavily criticised for too tight monetary policy, which can be interpreted as criticism of the Bank for attempting to attain the target too fast. This criticism does not seem to hold given the above results. A simple Taylor rule gives the same results. According to such a rule the policy rate of the Bank should have been raised much higher than was actually done when it peaked in October 2000 (see the discussion in *Monetary Bulletin*, 2002/2, p. 25-27).

Kuttner, 1996). Others, such as Mishkin (1999), argue that the success of inflation targeting in bringing inflation down and keeping it low will eventually be beneficial to growth after an initial period of unavoidable contraction as the disinflation process takes place, pointing to the growth record of many inflation targeting countries after adopting the new framework.

Table 8. Output growth prior to and after inflation targeting

Countries	*Average growth the 5 years prior to adoption*	*Average growth the year prior to adoption*	*Average growth after adoption*	*Growth 2002*	*Average growth 1981-90*	*Average growth 1991-02*
Australia	2.3	2.9	4.4	3.8	3.3	3.8
Brazil	2.6	0.6	2.5	1.5	2.4	2.6
Canada	2.9	-0.2	2.7	3.4	2.9	2.7
Chile	6.8	5.2	5.6	2.1	3.3	5.6
Columbia	1.7	-2.9	1.5	1.5	3.4	2.5
Czech Republic	2.3	-0.9	1.9	2.0	–	1.1
Hungary	4.4	4.5	3.4	3.2	1.2	1.8
Iceland	5.1	5.6	1.1	-0.5	2.9	2.5
Israel	4.5	6.2	3.9	-1.0	3.5	4.1
Korea	6.5	2.7	5.1	6.3	8.7	6.0
Mexico	2.9	4.5	2.3	0.9	1.7	2.8
New Zealand	1.0	-0.4	2.7	4.2	2.1	2.9
Norway	3.6	2.9	1.5	1.0	2.6	3.4
Peru	2.2	0.6	5.3	5.3	-0.2	4.0
Philippines	2.9	3.2	5.2	5.2	1.6	3.2
Poland	11.9	4.8	5.1	1.2	0.2	4.4
South Africa	2.6	2.0	3.1	3.0	1.6	2.0
Sweden	0.6	-1.7	2.9	1.9	2.1	2.2
Switzerland	1.3	1.5	1.4	0.1	2.1	0.8
Thailand	0.9	4.6	3.5	5.2	8.0	4.2
United Kingdom	1.6	-0.1	2.6	0.4	2.7	2.1
All countries	3.4	2.2	3.2	2.4	3.0	3.1
Except hyperinflation	2.9	2.0	3.0	2.6	2.9	3.1
Industrial countries	2.3	1.3	2.4	1.8	2.6	2.5
IT-6 group	2.5	0.9	3.5	2.6	2.7	3.2
Non-inflation targeting industrial countries	–	–	–	0.9	2.7	1.9

Quarterly data from 1981:1-2002:4 (except for New Zealand, where the data start in 1983:2, and the Czech Republic, where the data start in 1991:1). The table reports periodic averages for percentage changes in constant price GDP from the previous year's quarter. Information on the country groups can be found in Table 2.

Sources: EcoWin, IFS, central bank homepages and Central Bank of Iceland, Economics Department.

As reported in Table 8, growth has fallen slightly on average after inflation targeting, when looking at all the 21 countries. This is reversed when the four former hyperinflation countries are excluded, or when looking at the industrial countries or the IT-6 group. In these groups a slight increase in average growth is found. The growth record of the inflation targeting countries also compares quite favourably with

the non-targeting industrial countries, although the poor growth record in Japan might bias this comparison.

Table 8 also shows that growth in most industrial countries was quite small in the year before adopting the new regime, reflecting the general tendency to time the adoption in an economic slack when inflation is low (see also Schaechter et al., 2000). This is less obvious for the emerging market countries.

It is difficult to infer from Table 8 whether inflation targeting has affected growth. To do that a similar panel approach as used previously is adopted

$$(3) \qquad y_{it} = \alpha_{yi} + \beta_y IT_{it} + \gamma_y y_{it-1} + \mu_y (r_{it-1} - \pi_{it-1}) + \phi_y e_{it-1} + \lambda_{y0} y_t^w + \lambda_{y1} y_{t-1}^w + \varepsilon_{yit};$$
$$\text{with } i = 1,...,N; t = 1,...,T$$

where y_{it} output growth in inflation targeting country i at time t, $r_{it} - \pi_{it}$ is the real interest rate in inflation targeting country i at time t, e_{it} is the real exchange rate in inflation targeting country i at time t (a rise in e_{it} denotes an appreciation) and y_t^w is average output growth in six non-targeting industrial countries (Denmark, France, Germany, Italy, Japan and the US).

An alternative specification, similar to (1'), is also estimated. This specification includes the non-targeting industrial countries and Finland and Spain in the sample group

$$(3') \qquad y_{it} = \alpha_{yi} + \beta_y IT_{it} + \gamma_y y_{it-1} + \mu_y (r_{it-1} - \pi_{it-1}) + \phi_y e_{it-1} + \varepsilon_{yit};$$
$$\text{with } i = 1,...,N+M; t = 1,...,T$$

where the country sample includes N inflation targeting countries and a control group of $M - N$ countries. The results are shown in Table 9.[18] The positive effects of inflation targeting on output growth is only significant in country groups including the countries with relatively high inflation prior to adopting inflation targets. The ability of the model to explain output growth is also somewhat poorer than for inflation. There is, however, no evidence suggesting that inflation targeting has harmed growth.

These results are consistent with findings in the literature. Truman (2003) and Ball and Sheridan (2003) find positive effects of inflation targeting on growth, but these effects remain statistically insignificant (Ball and Sheridan, 2003) or on the

[18] As expected a real exchange rate appreciations and a higher real interest rate lowers growth and both effects are usually found statistically significant from zero. The interest rate and exchange rate data are described in Tables 11 and 13.

borderline (Truman, 2003). Again, there is no evidence that inflation targeting is harmful to growth. It is, however, appropriate to keep in mind, as pointed out by Ball and Sheridan (2003), that any effects of this new regime on growth are likely to take some time to emerge. The history of inflation targeting is therefore probably too short to give a definite answer on the link between inflation targeting and economic growth, even in the countries with the longest targeting history.

Table 9. Estimation of the effects of inflation targeting on output growth

	All countries	*Adoption prior to 2000*	*Adoption prior to 1999 and average inflation 1981-90 below 25%*	*Adoption prior to 1999 and average inflation 1981-90 below 15%*	*Industrial countries and adoption prior to 1999*
Estimate of β_y from (3)	0.151	0.257	0.136	0.154	0.263
	(0.073)	(0.085)	(0.141)	(0.164)	(0.177)
Estimate of β_y from (3')	0.160	0.179	0.109	0.148	0.141
	(0.058)	(0.065)	(0.084)	(0.090)	(0.092)

Definitions of country groups can be found in Table 3. Numbers in parenthesis are standard errors. The estimation period is 1981:1-2002:4 (T = 87). Information on the data and the countries for which data for the whole period was not available can be found in Tables 2, 8, 11 and 13.

3.2.2. Effects on growth variability

Table 10 compares fluctuations in output growth before and after inflation targeting, where output growth fluctuations are measured with standard deviations of output growth. It seems that growth variability has decreased in general after the adoption of inflation targeting, with the largest gain in emerging market countries. This is consistent with the findings in Corbo et al. (2001) and Neumann and von Hagen (2002), who show that that variability of growth and output gaps has fallen after inflation targeting. These findings are consistent with the view that flexible inflation targeting does not only reduce variability in inflation but also in growth, as discussed before. It is, however, hard to conclude whether this reduced variability can be attributed to the inflation target, or whether this is simply due to a more stable external environment in the targeting period. In fact Cecchetti and Ehrmann (2000) argue that increased focus on the inflation target may lead to increased output variability. The empirical results in Truman (2003), however, suggest a significant negative effect of inflation targeting on output fluctuations (although only at the 10% significance level). Ball and Sheridan (2003), however, find no significant effects.

Table 10. Output fluctuations prior to and after inflation targeting

Countries	*Average fluctuations the 5 years prior to adoption*	*Average fluctuations after adoption*	*Average fluctuations 1981-1990*	*Average fluctuations 1991-2002*
Australia	2.1	1.6	2.7	2.1
Brazil	1.6	1.8	3.3	1.9
Canada	2.2	2.0	3.0	2.0
Chile	1.8	3.3	5.9	3.3
Columbia	2.8	1.0	1.4	2.4
Czech Republic	2.4	1.5	–	3.4
Hungary	0.7	0.4	3.2	3.9
Iceland	2.6	2.8	5.4	3.6
Israel	3.0	3.8	2.9	3.7
Korea	3.1	6.5	2.8	4.7
Mexico	3.9	2.7	2.8	2.9
New Zealand	3.9	2.9	4.6	2.8
Norway	2.7	1.9	2.5	2.5
Peru	3.5	1.7	10.8	5.6
Philippines	1.4	2.0	4.4	1.9
Poland	11.8	4.9	5.7	14.5
South Africa	1.5	0.4	3.0	2.1
Sweden	1.9	1.8	2.0	2.3
Switzerland	1.1	1.5	1.9	1.3
Thailand	5.6	1.6	3.0	5.0
United Kingdom	2.5	1.5	2.1	1.9
All countries	3.0	2.3	3.3	3.5
Except hyperinflation	2.5	2.1	3.2	2.8
Industrial countries	2.4	2.0	3.0	2.3
IT-6 group	2.4	2.2	3.4	2.4
Non-inflation targeting industrial countries	–	–	1.8	1.6

Quarterly standard deviation of percentage changes in the constant price GDP from the previous year's quarter for the period 1981:1-2002:4. Information on the data can be found in Table 8. Information on the country groups can be found in Table 2.

Sources: EcoWin, IFS, central bank homepages and Central Bank of Iceland, Economics Department.

3.3. Effects on interest rates and exchange rates

3.3.1. Effects on interest rate level and monetary policy credibility

Table 11 shows that short-run nominal interest rates have in general fallen in the last decade, inflation targeters and non-targeters alike, consistent with the findings in Neumann and von Hagen (2002).[19] This is not surprising given the fall in inflation at the same time.

[19] In some respects a long-run interest rate would be more appropriate than a short-run rate but the latter was chosen due to a lack of continuous data for all the countries. More or less identical results to those reported here were found using the long-run data that was available.

Table 11. Short-run nominal interest rates prior to and after inflation targeting

Countries	*Average interest rates the 5 years prior to adoption*	*Average interest rates the year prior to adoption*	*Average interest rates after adoption*	*Interest rates 2002*	*Average interest rates 1981-90*	*Average interest rates 1991-02*
Australia	12.0	5.9	5.7	4.8	14.8	6.1
Brazil	28.1	30.6	18.9	21.3	–	23.2
Canada	10.3	12.7	5.1	2.7	11.2	5.1
Chile	23.8	35.2	14.2	2.8	30.5	13.0
Columbia	36.9	35.5	17.5	12.7	31.3	31.2
Czech Republic	9.0	10.8	6.9	2.7	–	7.9
Hungary	15.9	10.9	8.9	7.4	21.4	19.2
Iceland	8.2	11.1	9.7	6.4	–	8.1
Israel	18.8	13.5	11.4	9.2	22.0	11.5
Korea	14.0	15.9	6.9	4.9	12.1	11.4
Mexico	27.7	25.5	13.3	7.5	58.9	20.1
New Zealand	17.8	13.7	7.4	5.7	16.5	7.0
Norway	5.4	6.8	7.0	6.5	12.8	6.9
Peru	19.5	14.0	10.1	4.8	–	17.8
Philippines	11.5	9.7	5.5	5.2	18.0	12.5
Poland	25.1	23.1	16.3	7.8	24.7	16.1
South Africa	14.6	12.9	10.3	12.4	14.2	13.1
Sweden	11.9	12.7	5.3	3.7	11.9	6.5
Switzerland	1.8	1.3	2.3	0.6	4.7	3.3
Thailand	9.4	1.6	1.9	1.7	11.8	7.3
United Kingdom	12.0	10.2	5.9	3.9	11.4	6.6
All countries	15.9	14.9	9.1	6.4	18.8	12.5
Except hyperinflation	14.3	13.7	7.9	5.4	18.8	10.9
Industrial countries	9.9	9.3	6.0	4.3	11.9	6.2
IT-6 group	14.6	15.1	7.3	4.0	16.0	7.4
Non-inflation targeting industrial countries	–	–	–	2.0	9.8	4.9

Quarterly short-run interest rates (3 month treasury bill rates, money market rates or discount rates) for the period 1981:1-2002:4, except for Brazil (from 1996:1), the Czech Republic (from (1993:1), Hungary (from 1987:1), Iceland (from 1993:1), Israel (from 1986:1), Peru (from 1995:1) and Poland (from 1983:1). Information on the country groups can be found in Table 2.

Sources: EcoWin, IFS, central bank homepages and Central Bank of Iceland, Economics Department.

Increased credibility of monetary policy after inflation targeting should also be reflected in inflation expectations and the inflation risk premium on nominal interest rates. Both should lead to lower nominal interest rates. It is therefore interesting to test whether nominal interest rates have fallen by more than explained by the fall in inflation and the general fall in interest rates around the world, and whether this excess fall in interest rates can be attributed to the inflation targeting regime. To answer this question, the following panel model is estimated

(4) $$r_{it} = \alpha_{ri} + \beta_r IT_{it} + \gamma_r r_{it-1} + \delta_r \pi_{it} + \mu_r \pi_{it-1} + \phi_r y_{it-1} + \lambda_{r0} r_t^w + \lambda_{r1} r_{t-1}^w + \varepsilon_{rit};$$
with $i = 1,...,N; t = 1,...,T$

where r_{it} is the short-run nominal interest rate in inflation targeting country i at time t, π_{it} is the inflation rate in inflation targeting country i at time t, y_{it} is the output growth in inflation targeting country i at time t and r_t^w is the average interest rate in six non-targeting industrial countries (Denmark, France, Germany, Italy, Japan and the US).

Similar to (1') the model is also estimated including the non-targeting industrial countries and Finland and Spain in the sample group, with a linear trend capturing the downward trend in nominal interest rates (the quadratic trend was not found significant)

(4') $$r_{it} = \alpha_{ri} + \beta_r IT_{it} + \gamma_r r_{it-1} + \delta_r \pi_{it} + \mu_r \pi_{it-1} + \phi_r y_{it-1} + \lambda_{r1} t + \varepsilon_{rit};$$
with $i = 1,...,N+M; t = 1,...,T$

where the country sample includes N inflation targeting countries and a control group of $M - N$ countries. The results are shown in Table 12.[20]

Table 12. Estimation of the effects of inflation targeting on nominal interest rates

	All countries	*Adoption prior to 2000*	*Adoption prior to 1999 and average inflation 1981-90 below 25%*	*Adoption prior to 1999 and average inflation 1981-90 below 15%*	*Industrial countries and adoption prior to 1999*
Estimate of β_r from (4)	-0.310	-0.650	-0.618	-0.596	-0.422
	(0.091)	(0.137)	(0.155)	(0.158)	(0.164)
Estimate of β_r from (4')	-0.265	-0.355	-0.309	-0.308	-0.289
	(0.042)	(0.047)	(0.050)	(0.050)	(0.050)

Definitions of country groups can be found in Table 3. Numbers in parenthesis are standard errors. The estimation period is 1981:1-2002:4 (T = 87). Information on the data and the countries for which data for the whole period was not available can be found in Tables 2, 8 and 11.

The results suggest that inflation targeting has led to a fall in nominal interest rates beyond what can be explained by the fall in domestic inflation, the position of the domestic business cycle and the general global fall in interest rates. In all cases are the inflation targeting effects found statistically significant from zero. Inflation targeting therefore seems to have increased the credibility of monetary policy and reduced the inflation risk premium of nominal interest rates. This runs counter to the

[20] As expected, increased inflation and growth lead to rising nominal interest rates and the effects are usually found to be statistically significant from zero.

results in Ball and Sheridan (2003), who find no significant effects of inflation targeting on long-term interest rates.

This is, however, consistent with the findings in Bernanke et al. (1999), Corbo et al. (2001) and Johnson (2002) on the effects of inflation targeting on inflation expectations.[21] By using the slope of the yield curve and inflation expectations surveys, they find that after inflation expectations have fallen it remained easier for the inflation targeting central banks to keep them low in later upswings than had been possible prior to the inflation targeting regime. Their results suggest, however, that this credibility gain was only reaped some time after the adoption of the inflation target and that the effects were small at the start of the regime. The disinflation following the adoption of inflation targeting therefore came at a surprise, which is reflected in the fact that actual inflation often remained somewhat below measured inflation expectations for the first few years of the regime. This is also consistent with the findings in Ammer and Freeman (1995) and Bernanke et al. (1999) using VAR models based on data before the adoption of inflation targeting. These models consistently over-predict inflation for the first few years of the new regime.

This gradual gain in credibility is also found by Ammer and Freeman (1995), Debelle (1997) and Bernanke et al. (1999) analysing the effect of inflation targeting on the sacrifice ratio. Their results suggest that inflation targeting did not reduce the sacrifice ratio. The targeting countries had to go through a contraction to reduce inflation, which supports the above conjecture that the targeting regime initially lacked credibility. The results in Corbo et al. (2001) are slightly more positive, looking at a broader group of countries and measuring the sacrifice ratio using industrial production rather than GDP. Their results indicate that the adoption of inflation targeting led to a reduction in the sacrifice ratio, although the disinflation process still remained costly.

Closely related is the analysis in Kahn and Parrish (1998), Cecchetti and Ehrmann (2000), Corbo et al. (2001) and Neumann and von Hagen (2002) on whether inflation targeting has led to changes in central bank behaviour, especially concerning reaction to inflationary pressures. Using Taylor rules and impulse response analysis from VAR models, their results suggest that responses to transitory inflation shocks

[21] The empirical results from Johnson (2002) indicate the inflation targeting has reduced inflation expectations by 2½% on average, which is consistent with earlier findings in this paper on the effects of inflation targeting on average inflation.

have become less aggressive but long-run responses to inflation have increased. This suggests that monetary policy has become more forward looking after the adoption of inflation targeting. These studies also imply that monetary policy in the inflation targeting countries has been converging towards other industrial countries which have a long history of credibility, such as Germany and the US.

Improved credibility of monetary policy can also be read from comparing central bank performance in dealing with the two oil shocks in the late 1970s and 1990s. Neumann and von Hagen (2002) show that (after controlling for various economic factors) the inflation targeting central banks managed to keep inflation under control with much less interest rates hikes in the latter episode than in the first one. This suggests that monetary policy in the inflation targeting countries had gained greater credibility so that they found it much easier to cope with the second inflation shock. They also show that the credibility gain was much larger for the inflation targeting countries than for the non-targeting industrial countries in their study, implying that the adoption of inflation targeting played a crucial role in creating this increased credibility.

Together, these results suggest that the adoption of inflation targeting increased credibility of monetary policy in the targeting countries which reduced inflation expectations and the inflation risk premium in nominal interest rates. This credibility improvement was, however, not gained immediately. Announcing an inflation target does therefore not appear to be enough. The central bank needs to show real progress in fighting inflation and in the disinflation phase to be willing to accept temporary contraction in the real economy before credibility is gained.

3.3.2. Effects on fluctuations in exchange rates and interest rates

It is often argued that the adoption of inflation targeting will lead to increased exchange rate fluctuations as too much emphasis is placed on stabilising the domestic value of the currency instead of its external value. Various theoretical arguments do, however, suggest that low and stable inflation should contribute to exchange rate stability.[22] It has, however, been notoriously difficult to link exchange rate

[22] One should keep in mind that fluctuations in exchange rates are not bad *per se*. One of the benefits of floating exchange rates is that it acts as an absorber for real shocks. Exchange rates have a tendency, however, to fluctuate beyond what can be explained by economic fundamentals and it is this excessive volatility that is referred to in the main text. It is interesting to note in this connection that the results in Sabbán et al. (2003) suggest that the importance of real shocks in nominal and real exchange rate

fluctuations with any behaviour in economic fundamentals, cf. Kuttner and Posen (2000) who find that monetary policy transparency is more important for exchange rate volatility than fluctuations in economic fundamentals.

Table 13. Fluctuations in real exchange rates and real interest rates prior to and after inflation targeting

	Average fluctuations the 5 years prior to adoption		*Average fluctuations after adoption*		*Average fluctuations 1981-1990*		*Average fluctuations 1991-2002*	
Countries	Ex.rate	Int.rate	Ex.rate	Int.rate	Ex.rate	Int.rate	Ex.rate	Int.rate
Australia	9.3	1.9	6.7	1.6	9.6	2.6	6.6	1.8
Brazil	12.4	9.5	15.9	3.9	18.0	–	14.2	8.0
Canada	6.3	1.7	4.4	1.7	5.7	1.9	4.4	1.7
Chile	8.7	8.5	6.0	3.3	13.3	27.5	6.0	4.1
Columbia	9.5	4.2	8.4	2.6	10.3	4.0	9.5	5.3
Czech Republic	6.1	2.9	6.4	1.7	–	–	7.5	2.7
Hungary	2.8	1.6	2.0	1.2	6.3	5.4	5.7	4.2
Iceland	2.9	0.9	11.8	2.0	7.5	–	5.8	1.5
Israel	5.3	11.0	6.1	4.0	6.3	11.0	6.0	4.0
Korea	9.6	1.7	12.5	2.5	10.0	3.7	10.2	3.1
Mexico	18.1	10.8	7.0	2.6	22.8	27.1	13.0	7.5
New Zealand	11.3	2.9	7.5	1.3	9.4	4.1	7.8	1.3
Norway	2.4	1.4	3.8	1.1	3.0	2.8	4.2	2.8
Peru	5.1	6.7	2.5	5.6	21.8	–	9.2	6.7
Philippines	10.6	1.9	3.9	0.9	10.8	10.1	9.6	2.4
Poland	4.0	6.1	8.5	1.8	19.6	279.2	15.6	12.8
South Africa	8.7	2.0	10.6	1.9	13.1	5.2	8.7	3.2
Sweden	3.1	3.1	8.5	1.5	5.9	2.0	7.9	2.5
Switzerland	4.6	0.5	3.1	0.8	5.6	1.7	4.7	1.1
Thailand	11.1	3.8	4.7	0.7	6.8	3.3	7.6	3.2
United Kingdom	6.1	1.0	8.3	0.6	7.4	1.8	7.9	1.1
All countries	7.5	3.8	7.1	2.1	10.1	23.3	8.2	3.9
Except hyperinflation	7.7	2.9	6.8	1.7	9.2	6.0	7.5	2.9
Industrial countries	5.8	1.7	6.8	1.3	6.8	2.4	6.2	1.7
IT-6 group	7.5	2.9	6.9	1.9	8.5	4.4	6.8	2.1
Non-inflation targeting industrial countries	–	–	–	–	6.2	1.5	5.9	2.0

The real exchange rate data is quarterly for the period 1981:1-2002:4 (except for the Czech Republic, where the data start in 1990:4). The data is obtained from the International Monetary Fund (except for Iceland (from the Central Bank of Iceland) and for Brazil, Peru and Thailand (from JP-Morgan)). The table reports the standard deviations of percentage changes in the real exchange rate from the previous year quarter. The real interest rate is calculated by subtracting annual inflation in a given quarter from the same quarter's nominal interest rate. The table reports the standard deviations of interest rate levels. Information on the inflation and interest rate data can be found in Tables 2 and 11. Information on the country groups can be found in Table 2.

Sources: EcoWin, IFS, JP-Morgan, central bank homepages and Central Bank of Iceland, Economics Department.

fluctuations have increased after the adoption of inflation targeting, suggesting that the ability of the exchange rate to act as a shock absorber has increased after the adoption of inflation targeting.

Table 13 compares fluctuations in real exchange rates before and after inflation targeting. Exchange rate fluctuations are calculated using standard deviations of annual real exchange changes.[23] Real exchange rate variation seems to have fallen on average when looking at all the inflation targeting countries. In fact it seems only in the industrial countries that exchange rate fluctuations have increased on average.[24] When looking at individual countries it appears that exchange rate fluctuations have increased in ten countries, but fallen in eleven. It does therefore not seem obvious that inflation targeting necessarily leads to increased exchange rate volatility. In fact, it is interesting that all the four industrial countries, where exchange rate variability increases, were previously on a fixed exchange rate (a discussion on the previous exchange rate framework is given in Pétursson, 2004). In addition, four of the six emerging market countries previously using fixed exchange rates experienced an increase in exchange rate variability after adopting inflation targeting. Exchange rate fluctuations, however, fell in all the four industrial countries and in four of the seven emerging market countries previously on a floating exchange rate.

Increased exchange rate volatility therefore seems to be related to exiting a fixed exchange rate regime rather than to the adoption of inflation targeting *per se* (see also the results in Gudmundsson, 2001). Inflation targeting seems to have reduced exchange rate volatility rather than increasing it in those countries which had a floating exchange rate before adopting inflation targeting, consistent with Kuttner and Posen (2000), who argue that increased transparency of monetary policy reduces exchange rate variability. A discussion on the interaction between monetary policy and exchange rate variability in an inflation targeting regime can be found in Mishkin and Schmidt-Hebbel (2001).

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[23] Exchange rate fluctuations were also calculated as the standard deviations of the real exchange rate level, as the standard deviation of quarterly changes in the real exchange rate, and as the percentage difference between the peak and through of the exchange rate cycle within each regime. The main results continue to hold, irrespective of the measure of exchange rate fluctuations used. The same applied whether the nominal or real exchange rate were used. Note, however, that these measures do not capture prolonged deviations from equilibrium exchange rates which are just as important as the short-run fluctuations in exchange rates capture here. With modern financial hedging opportunities available one may even argue that these latter type of fluctuations are more important.

[24] One should be careful in comparing exchange rate fluctuations prior to and after inflation targeting for countries which have very recently adopted the new regime as the short period after adoption may not be representative for exchange rate fluctuations that will follow the adoption of inflation targeting. This especially applies to countries such as Iceland where the new regime was adopted after the currency came under heavy pressure, with large exchange rate fluctuations following the abolishment of the exchange rate peg during which the accumulated disequilibrium was corrected. This might influence the results.

Some of those sceptical about the usefulness of inflation targeting also worry that a too rigid framework will lead to excessive fluctuations in monetary policy instruments, i.e. that variability of short-term interest rates will increase with inflation targeting. This is, however, not obvious as one can easily argue that interest rate volatility can be larger in a fixed exchange rate framework, especially when the central bank is defending the peg against a speculative attack, cf. the Swedish experience in the early 1990s.

Table 13 compares fluctuations in short-term real interest rates prior to and after inflation targeting. Interest rate variability falls in general after adoption,[25] consistent with the results in Kahn and Parrish (1998) and Neumann and von Hagen (2002). This suggests that the weight of short-run developments in the formulation of monetary policy has decreased and that the medium-term horizon is more prominent, as discussed earlier. The results also suggest that inflation targeting central banks do not interpret the framework as a rigid rule (as strict inflation targeting, cf. Svensson, 2001), but rather as a flexible framework where interest rate smoothing is important, contributing to increased stability of the real economy and reduced probability of financial instability.

3.4. The total long-run level effects of inflation targeting

A potential shortcoming of the above analysis is that it only estimates the direct effects of inflation targeting on macroeconomic variables, e.g. estimating the direct impact on inflation but holding the effects on output and interest rates constant, thus omitting the potential effect on inflation operating through its impact on output growth and interest rates.[26] Thus, for example, if output effects inflation and the interest rate affects output then there are indirect effects of inflation targeting on inflation via its effects on interest rates and output. The same would be true for all variables if such feedback effects exist, thus biasing the true total, long-run effects of inflation targeting on macroeconomic performances although it is unclear in what direction this bias would be.

[25] Fluctuations in interest rates only increase in three countries (Iceland, Korea and Switzerland) and two of these have adopted inflation targeting very recently. This might complicate the interpretation of the results. It is also interesting that interest rate volatility has increased in the non-targeting industrial countries. The results remained more or less the same whether nominal or real, or short or long, interest rates were used.

[26] I would like to thank Mike Wickens for suggesting this point.

To work out this total effect, one can write the three-dimensional system as follows

$$\text{(5)} \qquad \mathbf{A}_0\mathbf{x}_t = \boldsymbol{\beta} IT_t + \mathbf{A}_1\mathbf{x}_{t-1} + \boldsymbol{\Phi}\mathbf{z}_t + \boldsymbol{\varepsilon}_t$$

where $\mathbf{x}_t = (\pi_t, y_t, r_t)'$, $\boldsymbol{\beta} = (\beta_\pi, \beta_y, \beta_r)'$, $\mathbf{z}_t$ is a vector containing all the exogenous variables, $\boldsymbol{\varepsilon}_t$ is a residual vector, and $\mathbf{A}_0$, $\mathbf{A}_1$ and $\boldsymbol{\Phi}$ are coefficient matrices.

This system has the following long-run solution

$$\text{(6)} \qquad \mathbf{x} = \boldsymbol{\Omega}^{-1}\boldsymbol{\beta} IT + \boldsymbol{\Omega}^{-1}\boldsymbol{\Phi}\mathbf{z} = \boldsymbol{\theta} IT + \boldsymbol{\Omega}^{-1}\boldsymbol{\Phi}\mathbf{z}$$

where $\boldsymbol{\Omega} = (\mathbf{A}_0 - \mathbf{A}_1)$. The total long-run effects of inflation targeting are therefore given by (where the direct long-run effects can be read off the diagonal)

$$\text{(7)} \qquad \boldsymbol{\theta} = \begin{pmatrix} 1-\gamma_\pi & -\mu_\pi & 0 \\ \mu_y & 1-\gamma_y & -\mu_y \\ -(\delta_r + \mu_r) & -\phi_r & 1-\gamma_r \end{pmatrix}^{-1} \begin{pmatrix} \beta_\pi \\ \beta_y \\ \beta_r \end{pmatrix}$$

Table 14 compares the direct and total long-run effects (with standard errors calculated using the delta method) with non-significant variables removed in the final system estimation. The total effects on inflation are either slightly smaller or equal to the direct long-run effects. The same applies to the output effect, whereas the total interest rate effect is more often larger than the direct effect. These differences are however small. The direct inflation effect is on average (across country samples and model specifications) 0.5 percentage point larger than its corresponding total effect. The direct output effect is on average 0.3 percentage point larger, and the direct interest rate effect on average 40 basis points larger. Furthermore, the statistical inference remains largely unchanged; the only changes are that the long-run inflation effect becomes statistically insignificant in the second country sample using equation (1) and the first country sample using equation (1') (with the second country sample now only significant at the 10% significance level).

Table 14. Direct and total long-run effects of inflation targeting

	All countries	*Adoption prior to 2000*	*Adoption prior to 1999 and average inflation 1981-90 below 25%*	*Adoption prior to 1999 and average inflation 1981-90 below 15%*	*Industrial countries and adoption prior to 1999*
			Inflation		
Equation (1)					
Direct effect	-1.077	-2.353	-3.326	-3.030	-2.207
	(0.769)	(0.928)	(1.002)	(1.241)	(1.496)
Total effect	-0.005	-1.066	-3.147	-3.030	-2.021
	(0.978)	(1.068)	(1.057)	(1.241)	(1.596)
Equation (1')					
Direct effect	-1.332	-1.922	-2.127	-1.909	-1.916
	(0.564)	(0.711)	(0.849)	(0.922)	(1.047)
Total effect	-0.362	-1.226	-1.912	-1.909	-1.916
	(0.617)	(0.736)	(0.890)	(0.922)	(1.047)
			Output growth		
Equation (3)					
Direct effect	1.569	1.859	0.515	0.531	0.787
	(0.757)	(0.629)	(0.528)	(0.553)	(0.508)
Total effect	1.653	1.569	0.340	0.000	0.111
	(1.101)	(0.561)	(1.834)	–	(0.110)
Equation (3')					
Direct effect	1.287	1.108	0.487	0.619	0.584
	(0.466)	(0.405)	(0.375)	(0.376)	(0.377)
Total effect	1.603	1.080	0.318	0.000	0.000
	(0.436)	(0.393)	(2.992)	–	–
			Interest rates		
Equation (4)					
Direct effect	-3.103	-5.480	-3.794	-4.061	-3.215
	(0.763)	(0.975)	(0.834)	(0.943)	(1.129)
Total effect	-1.992	-4.084	-4.878	-5.197	-3.980
	(0.923)	(1.119)	(0.813)	(1.187)	(1.174)
Equation (4')					
Direct effect	-4.623	-6.269	-5.371	-5.623	-5.664
	(0.757)	(0.898)	(0.961)	(1.033)	(1.127)
Total effect	-2.449	-4.460	-5.113	-5.738	-5.651
	(0.877)	(0.973)	(0.793)	(0.949)	(1.022)

The table reports the estimated long-run effects of inflation-targeting adoption. The direct long-run effects are calculated as $\beta_k/(1 - \gamma_k)$, where $k = \pi, y, r$. The total long-run effects are calculated from equation (7). Standard errors, reported in parenthesis, are calculated using the delta method: $V(\boldsymbol{\theta}(\boldsymbol{\kappa})) = (\partial\boldsymbol{\theta}(\boldsymbol{\kappa})/\partial\boldsymbol{\kappa})' V(\boldsymbol{\kappa})(\partial\boldsymbol{\theta}(\boldsymbol{\kappa})/\partial\boldsymbol{\kappa})$, where $V(\boldsymbol{\kappa})$ is the variance-covariance matrix of the original coefficients ($\boldsymbol{\kappa}$), and $V(\boldsymbol{\theta}(\boldsymbol{\kappa}))$ is the variance-covariance matrix of the derived long-run coefficients ($\boldsymbol{\theta}$).

5. Conclusions

Monetary policy based on an inflation target has gained increasing attention and popularity since New Zealand first adopted this framework in early 1990. By 1993 only five countries had adopted inflation targeting and five years later they were ten. Five years further the number of countries had doubled, with 21 countries currently basing their monetary policy on an inflation target.

A substantial literature analysing the effects of inflation targeting has developed over the last few years. The main conclusions from this literature is that the adoption of inflation targeting has made it possible for central banks to bring inflation down and to keep it low, with inflation also more stable. Inflation expectations have also fallen, though some studies suggest that they fell only after the new framework gained more credibility. Inflation persistence has also fallen, reflecting the improved credibility of policy and suggesting that inflation expectations have become more forward looking than before. These changes are also reflected in lower nominal interest rates. These results are supported by the findings in this paper and found to robust to changes in the country sample, model specification and sample period.

There is, however, no evidence that these gains have come at a cost of lower output growth or increased output variability. Some studies in fact suggest that the adoption of inflation targeting have led to an improved growth performance. The sacrifice ratio of disinflation has, however, not fallen greatly which supports the above mentioned results that the mere announcement of inflation targeting is not sufficient to improve credibility. It is still the case that monetary policy has to show real progress before gaining more credibility.

The effects of inflation targeting on exchange rate variability are not clear. Exchange rate fluctuations have generally diminished in those countries that previously had a flexible exchange rate with an alternative nominal anchor, possibly due to greater transparency of monetary policy under inflation targeting. Those countries where exchange rate fluctuations have increased are usually former fixed exchange rate countries. Increased exchange rate variability therefore seems more due to the abolishment of the exchange rate peg rather than the adoption of inflation targeting *per se*.

It is sometimes claimed that the inflation targeting framework has not been tested by adverse shocks which could provide evidence on the durability of the framework. A number of studies show, however, that this is not correct. The oil price shock in 1998 is a prime example where many inflation targeting central banks managed to keep inflation at check with much less aggressive monetary policy stance, compared to the oil price shock in the late 1970s. This suggests that the credibility of monetary policy was much greater by the time of the second shock. Other tests include the large terms of trade shock experienced by many inflation targeting central countries in the aftermath of the East Asian crisis. The same can be said about the

bursting of the stock market bubble and the consequences of September 11. Many inflation targeting countries have also tackled home-made problems which they feel they can handle more easily after inflation targeting. An example is the depreciation of the Swedish krona after the abolishment of the exchange rate peg in the early 1990s and the response of monetary policy in Canada to the hike in indirect taxes in its first year of inflation targeting.

These results suggest that inflation targeting, by increasing the transparency and accountability of the central bank, has led to improved understanding and greater credibility of monetary policy. Discussions on monetary policy inside and outside the central bank reflect better what the main tasks of monetary policy are and which goals it can achieve and which not. This makes it easier for the central bank to achieve its goals with smoother adjustments in its policy stance. Inflation targeting has in many ways made it possible for countries with persistent inflationary problems to turn around the corner and bring its monetary policy in line with best practice around the world. In many respects they have even been leading in creating a new benchmark for how to formulate monetary policy.

Inflation targeting is, however, no panacea. Complicated problems requiring careful analysis will continue to arise. Mistakes will inevitably continue to be made. Monetary policy will still need to decide on the causes and durability of shocks and the issue of how to deal with supply shocks will not disappear. The same applies to the role of exchange rate developments in the formulation of monetary policy in a small, open economy, especially where the domestic financial system is relatively underdeveloped so that excessive exchange rate fluctuations can undermine its stability. Conflicts between the inflation target and financial stability can also create problems, as do inconsistencies between monetary and fiscal policy. The key is, however, that flexible inflation targeting provides a framework which increases the probability that monetary policy reaches the correct decisions and that these decisions are explained in a clear and credible fashion.

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