The role of short-run inflation targets and forecasts in disinflation

*Lavan Mahadeva**
and
*Gabriel Sterne***

Working Paper no. 167

* Centre for Central Banking Studies, Bank of England, Threadneedle Street, London, EC2R 8AH.
E-mail: lavan.mahadeva@bankofengland.co.uk
** International Economic Analysis Division, Bank of England, Threadneedle Street, London, EC2R 8AH.
E-mail: gabriel.sterne@bankofengland.co.uk

The paper was originally prepared for the Money Macro and Finance Group Conference meeting 'Beyond Inflation Targeting' London. The authors are grateful to Reginald Ajuonuma, Bill Allen, Georgios Chortareas, Mark Cornelius, Spencer Dale, Peter Doyle, Joe Ganley, Dan Huynh, Norbert Janssen, Tomasz Lyziak, Marion Kohler, Viktor Kotlan, Marcus Miller, Frederic Mishkin, Paul Robinson, Peter Sinclair, Mark Stone and Mark Zelmer for helpful comments and contributions and to participants at seminars at the Bank of England and MMFG conference. We are also grateful to our two anonymous referees for their comments, and particularly to the series editor Simon Price for making many useful suggestions. We also thank all those central banks that took part in the survey on which the paper is based.

Copies of working papers may be obtained from Publications Group, Bank of England, Threadneedle Street, London, EC2R 8AH; telephone 020 7601 4030, fax 020 7601 3298, e-mail mapublications@bankofengland.co.uk

Working papers are also available at www.bankofengland.co.uk/wp/index.html

The Bank of England's working paper series is externally refereed.

ISSN 1368-5562

Contents

Abstract

Globally, the majority of countries using inflation targets have done so when inflation was neither low nor stable. Many such countries have changed their target each year, and our empirical estimates support theoretical predictions that annual changes to the target are endogenous to outcomes. We use a unique cross-country panel dataset of inflation targets and outcomes in 60 countries in the 1990s. Our estimates suggest the target revision may be predicted according to a simple 'forecasting' rule, and depends upon the outcome's deviation from both the short-run and long-run target. During disinflation, policy-makers may therefore be characterised as using two types of policy rule; one for setting interest rates, the other for revising annual targets. In designing roles for the legislator and the central bank in the monetary framework, it is necessary to take into account the likelihood that the process of setting the target may, in some circumstances, be inseparable from that of setting policy instruments. In the light of other literature, we also argue that during disinflation, short-run targets may help central banks to build credibility because they may increase transparency.

Summary

Globally, the majority of countries using inflation targets have done so when inflation was neither low nor stable. In low-inflation economies, the adoption of inflation targets has typically been associated with more comfortable institutional arrangements. In contrast, central banks in emerging economies have found that – notwithstanding the contribution of inflation targets towards the attainment of price stability – they have provided a relatively less comfortable nominal anchor.

In this paper we suggest reasons why the use of inflation targets may be more complicated during disinflation. The central bank may have to tread gingerly towards achieving its long-run inflation target, since:

a) the current inflation rate may be markedly different from the long-run target;
b) the output costs of moving to the long-run inflation target within one or two years are expected to be large; and
c) the short-run behaviour is driven by many large and uncertain developments.

Our simple theoretical model encompasses these features. It differs from previous work insofar as the central bank cares not just about deviations of inflation from the long-run target of price stability, but also about deviations from a short-term path, which itself may be revised in the future. The results suggest that the short-run target path may be akin to a state-contingent forecast, and that annual changes to the short-run target may be predicted given information about the anchor (the long-run target) and full knowledge about shocks hitting the economy.

We use (and publish) a new and unique cross-country dataset of targets and outcomes during the 1990s to assess how the role and contribution of inflation targets is affected by their use during disinflation. Our panel estimates support theoretical predictions that annual changes to the target are endogenous to outcomes for inflation. We estimate an equation relating the annual change in the short-run inflation target to the deviation of inflation from the long-run target, and also to the miss from the short-run target in the most recent year. Across a very broad range of countries the results suggest that policy-makers may be characterised as revising their short-run targets according to a simple forecasting rule: they tend to revise their targets down in proportion to excess of inflation above the long-run 'target' of price stability; they also revise short-run targets up or down almost in line with the miss from last year's short-run target. They may be using such a rule for revising targets in conjunction with the more familiar policy rule for revising interest rates. So models of disinflationary policies may need to take into account both of these rules.

We draw a number of policy conclusions, the first of which stems directly from our analysis:

1. *In designing roles for the legislature and the central bank in the monetary framework it is necessary to take into account the likelihood that, during disinflation, the process of setting or revising the inflation target may at times be inseparable from that of setting policy instruments.* So in contrast to low inflation countries such as the United Kingdom – where it has been possible to devise an effective monetary framework in which the government sets

the target and has not changed it since it delegated the Bank of England instrument independence to meet the target – during disinflation it is more complicated to design a monetary strategy that attempts to utilise distinctions between the roles of setting interest rates and those of setting the short-run target.

We draw other policy implications by considering our results in conjunction with other work:

2. *Short-run targets (or forecasts) may contribute towards building credibility even if they are more akin to state-contingent forecasts than policy rules.* Although our simple theoretical model and empirical results do not demonstrate any benefits from using inflation targets, the expanding literature on central bank transparency suggests that forecast publication may enhance credibility and lead to lower inflation.

3. *Short-term money and inflation targets need not necessarily be seen as alternatives during disinflation.* When targets are viewed as being more akin to state-contingent forecasts than rules, the case for viewing inflation and money targets as alternatives is undermined. Publishing forecasts for more than one variable – provided they are mutually consistent – may *increase* transparency, since publishing a forecast for more than one variable may inform the public better about the central bank's opinion regarding the nature of recent shocks to the economy.

4. *There do not necessarily exit any prerequisites for the introduction of inflation targets.* The results discussed here lead us to argue that there may exist potential marginal benefits from increasing transparency through the introduction of inflation targets (or state-contingent inflation forecasts) even if other aspects of framework reform commonly associated with inflation targeting are not yet fully in place. We site evidence that suggests that the transparency channel for reducing inflation may be stronger in high-inflation economies, where credibility is likely to be lower.

1 Introduction

Over 50 countries were using an explicit inflation target in 2000. And in over three-quarters of these countries inflation was well above a rate consistent with price stability. We use a unique cross-country dataset of targets and outcomes during the 1990s to assess how the role and contribution of inflation targets is affected by their use during disinflation. The issues are of interest to the large number of floating exchange rate countries implementing a disinflationary strategy, and to industrialised countries contemplating how their inflation-targeting framework might operate in less benign economic conditions than have usually been faced since the early 1990s.

Previous work on the use of inflation targets during disinflation (eg Corbo *et al* (2002)) has included estimates of policy rules and has found significant evidence that deviations from inflation targets have influenced interest rates in half of the tested disinflating countries. There has been less focus, however, on the significance of target revisions. Our estimates show short-run targets are generally revised according to a predictable 'forecasting' rule, whereby the revision of the target is in line with the miss from the short-run target, and also depends upon the deviation of inflation from the long-run objective of price stability. A short-run target during disinflation can therefore be characterised as a 'cross-breed' animal. Some of its properties may resemble a policy rule. Yet they are typically revised in a way that is more akin to a forecast. We draw on our analysis and on other work to focus on the implications for framework design and credibility-building during disinflation.[(1)]

In Section 2 we reflect on policy-makers views on the use of inflation targets in disinflating economies and in countries with low inflation. Section 3 describes the data we use and provides evidence of a rapid increase in the use of inflation targets in the 1990s, particularly in disinflating countries. Section 4 assesses the challenge faced by monetary policy makers when using inflation targets during episodes of disinflation. We argue that it is inherently more difficult during disinflations to provide distinct and comfortable roles for both government and the central bank that enable target-setting and instrument-setting to be clearly distinguished. The reason, we argue, is that the targeted path towards low inflation is endogenous to outcomes during the disinflationary episode. A short-run target undershoot is more likely to result in a downward revision to the announced targeted path than an overshoot. We present a simple theoretical model that helps to illustrate why the target set may become endogenous to previous inflation outcomes. Section 5 presents panel-estimates suggesting how target revisions are predictable, and Section 6 uses the results and other research to draw implications for the design of monetary frameworks.

---

(1) Other papers have focused on the implications of particular aspects of the transmission mechanism during the transition to low inflation. For example Cufer, Mahadeva and Sterne (2000) assess the role of administered prices. Eichengreen (2001) assesses implications of various structural differences between emerging markets and industrialised economies.

2 Assessing practitioners' views

In low-inflation economies, the adoption of inflation targets has frequently been associated with more comfortable institutional arrangements. These arrangements have often provided a clear role for each of the central bank and government in setting inflation targets and in deciding upon policy interest rates. At the 1999 Central Bank Governors' Symposium held at the Bank of England,[(2)] Gordon Thiessen (Canada) reported that inflation targets had 'changed enormously my relationship with the House of Commons standing committee.' Reserve Bank of New Zealand Governor Donald Brash cited similar advantages of inflation targets, and the Bank of England's Deputy Governor Mervyn King reported: '[t]he process works because [the MPC] do not question each other about the objective. We have a very clear objective, which is the inflation target. And when there is a discussion about what that target should be, it takes place outside the Committee.'

Governors from disinflating economies have typically qualified their enthusiasm for inflation targeting. In completing his address at the same symposium Josef Tošovskỳ (Czech), Governor of the first central bank in a transitional economy to undertake inflation targeting, completed his address by stating 'I would welcome you in joining the club, but you should know that this nominal anchor is not a panacea for small open emerging economies.'

In contrast to King's depiction of the UK process, the distinction between target-setting and instrument-setting may become blurred during disinflation, as policy-makers are typically involved in regular (often monthly) discussions about changing interest rates and also less frequent (usually annual) discussions about what the short-run target should be. In principal, such dual discussions could be avoided by either of two means:

First, at the outset of the disinflation, the target-setter could commit to multi-year targets that map the entire course of the disinflation process. Yet this has rarely happened,[(3)] in part because there is a strong likelihood that in countries where high inflation may have undermined initial credibility, the announcement may not be perceived to be time-consistent. Walsh (1998, page 321) defines an action as time-consistent if 'an action planned at time t for time $t+i$ remains optimal to implement when time $t+i$ actually arrives.' In practice, the disinflation path is generally highly uncertain in terms of duration and smoothness, because policy-makers expect inflation to be knocked from its targeted path by unforeseeable shocks[(4)] that may imply high output costs if policy aims to stick rigidly to a pre-specified path. A trade-off emerges: announcing a clear targeted disinflation path might potentially influence inflation expectations by more than the announcement of only a short-term target. Conversely, if the detailed path is missed, credibility may be undermined even if the disinflation is broadly on track.

---

(2) See Mahadeva and Sterne (eds), pages 182-205.

(3) By 2000, Mexico and Peru announced targets for each year to 2003. Few other countries have expressed the time path in such detail.

(4) Even Chile, the country whose inflation rate during its disinflation was amongst the smoothest ever achieved, refrained from specifying a multi-year disinflation path at any stage in the disinflation process. Landerretche, Morande and Schmidt-Hebbel (2000) argue that the benefits of short target horizons during disinflations may be balanced by costs, since they 'may force central banks to overreact to price shocks in order to meet their targets at the cost of causing excessive output volatility, contributing also to more variability of interest and exchange rates.'

Second, the government could assume complete responsibility for regularly revising the inflation target it sets the central bank. But government responsibility to set short-term inflation targets may undermine instrument independence. Responses to the survey of Fry, Julius, Mahadeva, Roger and Sterne (2000) (henceforth FJMRS)[5] indicated that central bankers in disinflating countries were relatively more likely to define independence according to the capacity to set their own targets or objectives.[6] In the words of one respondent 'What good is instrument independence if the Parliament or Cabinet sets politically motivated goals that are binding?'

So in practice it has been relatively difficult for monetary policy makers in disinflating economies to specify what should happen if the short-term target is missed. What should policy-makers do if inflation falls below the short-run target but remains above the long-run objective for inflation?[7] Should they change interest rates to increase inflation to the short-term target, or should they operate a policy of opportunistic disinflation by revising the short-run target down? The following investigates what has happened in practice.

3 The spread of inflation targets in a decade of disinflation

Experiences of the 1990s afford an unprecedented opportunity to assess the context for the use of inflation targets during disinflations. First, the decade can be characterised as one of relatively orderly disinflation in each of low, medium and high-inflation groups of countries.[8] Second, the decade witnessed a rapid increase in the use of inflation targets and the adoption of other aspects of institutional reform, such as increased independence and transparency of central banks.[9]

Using data from one of the broadest-ever surveys of monetary frameworks contained in FJMRS, extended by the authors, Table 1 illustrates that 61 of the 95 economies surveyed have used explicit inflation targets between 1990 and 2001. Inflation targets have been used in a very broad range of circumstances and policy frameworks. The table illustrates in detail the years in which countries have used explicit (ie published) inflation targets, when they were adopted, and, where appropriate, when they were dropped, and Table 2 summarises the same information. Early assessments of inflation targets were relatively cautious about their likely durability.[10] How would policy-makers react, for example, in the face of severe supply shocks that might lead to a tension between achieving the target and accommodating the shock? Our data cover over 300 country-years of experience with inflation targets and their durability is very well established. In our data the only instances of inflation targets having been dropped are in the cases when countries have chosen to join European Monetary Union.

---

[5] Their survey covers a broad range of institutional issues, central bank objectives, analysis conducted and structural factors. Here, we focus primarily on those issues that particularly relate to inflation targets.
[6] See FJMRS, pages 111-12, where the authors contrast central bankers' definitions of independence. FJMRS report that 'Inflation targeting central banks in low inflation countries did not generally regard the ability to set the target as important in assessing their own independence.' These responses are in stark contrast to those from disinflating countries using inflation targets.
[7] Price or monetary stability is an important statutory objective of 96% of central banks covered in the FJMRS survey (see Mahadeva and Sterne, (2000), page 9). And in 83% of all central banks no other conflicting statutory objective was specified.
[8] See FJMRS, pages 18-28.
[9] See Sterne (2002).
[10] See, for example, Haldane (1995, page v).

Table 1: Central banks using explicit inflation targets since 1990
(with dates they were adopted and dropped)

	Central banks reporting use of explicit inflation targets: (61 economies from a total of 95 in the survey)			Of which, defined as: 'inflation targeters'[1]	Inflation targeting with low and stable inflation targets[2]
	30			**7**	**1**
Developing	Malaysia (70s–)	Nigeria (93–)	Sierra Leone (96–)	Chile (91–)	Thailand (00–)
	Tanzania (80s–)	Vietnam (93–)	W. Afr. States (97–)	Colombia (91–)	
	Mozambique (87–)	Bangladesh (94–)	China (98–)	Peru (94–)	
	Chile (91–)	Ecuador (94–)	Kenya (98?)	Brazil (98–)	
	Colombia (91–)	Mexico (94–)	Lebanon (98–)	Mexico (99–)	
	Egypt (91–)	Peru (94–)	Turkey (98–)	South Africa (00–)	
	India (91–)	Uruguay (95–)	Brazil (98–)	Indonesia (00–)	
	Uganda (92–)	Zambia (95–)	South Africa (00–)		
	Indonesia (92–)	Jamaica (96–)	Indonesia (00–)		
	Guyana (93–)	Mauritius (96–)	Thailand (00–)		
	16			**2**	
Transitional	Poland (92–)	Armenia (95–)	Romania (97–)	Czech Rep. (98–)	
	Albania (93–)	Moldova (96–)	Slovenia (97–)	Poland (98–)	
	Macedonia (93–)	Georgia (96–)	Turkmenistan (97–)		
	Russia (93–)	Kazakhstan (97–)	Czech Rep. (98–)		
	Slovakia (93–)	Kyrgyz (96–)			
	Croatia (94–)	Mongolia (97–)			
	15			**11**	**11**
Industrialised	New Zealand (88–)	UK (92–)	Italy (95–98)	New Zealand (88–)	New Zealand (88–)
	Greece (90? –)	Australia (93–)	Spain (94–98)	Israel (91–)	Canada (92–)
	Taiwan (90?–)	Finland (93–98)	Korea (98–)	Canada (91–)	UK (92–)
	Canada (91–)	Sweden (93–)	Switzerland (00–)	UK (92–)	Australia (93–)
	Israel (91–)	France (94–98)	Iceland (01–)	Australia (93–)	Finland (95–98)
				Finland (93–98)	Sweden (95–)
				Sweden (93–)	Spain (94–98)
				Spain (94–98)	Taiwan (97–)
				Korea (98–)	Korea (98–)
				Switzerland (00–)	Switzerland (00–)
				Iceland (01–)	Iceland (01–)

1 'inflation targeters' are categorised in accordance with Mishkin and Schmidt-Hebbel (2002), updated by authors.
2 We define low and stable inflation targets as those whose targets are less than or equal to 3%.
3 Germany and Switzerland (up to 1999) had explicit long-term objectives for inflation but are not included in the table since the central banks did not regard these as inflation targets. A '?' is included for Greece, Kenya and Taiwan because we are not sure if inflation targets were used before 1990.

Sources: FJMRS (2000), updated by the authors. The updated sample includes a total of 95 economies, with Brazil and Colombia being the countries added since the original survey.

The literature on inflation targets has concentrated most on drawing lessons from the experience of a relatively narrow group of countries that are classified as 'inflation targeters'.[(11)] The distinction between an 'inflation targeter' and a country using inflation targets is inevitably arbitrary. It is relatively clear which countries are using published inflation targets, but definitions of 'inflation targeting' incorporating a broad array of framework characteristics.[(12)] Our unique dataset provides us with the opportunity to minimise potential definitional problems by looking at the use of inflation targets first, in all countries in which they have been used, and second in the sub-group of countries loosely defined as 'inflation targeters'. For the latter, which account for under a third of the total number of countries using inflation targets, we follow

[(11)] See, for example, Haldane (1995), Leiderman and Svensson (1995), Bernanke, Laubach, Mishkin and Posen (1999). More recently, Mahadeva and Sterne (2000) and Loayza and Soto (2002) place relatively greater emphasis on the experiences of emerging economies.

[(12)] See Sterne (2002). According to Mishkin and Schmidt-Hebbel, 'full-fledged inflation targeting is based on five pillars: an institutional commitment to price stability, absence of fiscal dominance, absence of other nominal anchors, policy instrument independence, and policy transparency and accountability.' Other definitions of inflation targeting include the absence of other published targets and the nature of analysis conducted.

Mishkin and Schmidt-Hebbel's (2002) classification. We note, however, that even in 2000, the number of 'inflation targeters' is little over a third of those countries using explicit inflation targets (Table 2).

Table 2: The number of countries using inflation targets since 1990

	Countries with inflation targets	Of which: 'Inflation targeters'	Low and stable targets* (targets ≤ 3%)	Disinflating* (targets > 3%)
1990	7	1	0	7
1991	11	4	2	9
1992	14	4	2	12
1993	23	9	3	20
1994	30	11	5	25
1995	37	11	7	30
1996	43	11	7	36
1997	49	11	8	41
1998	56	15	9	47
1999	52	14	7	45
2000	56	17	9	47
2001	57	18	10	47

* Our definition of 'disinflating' countries is empirically appropriate since virtually all countries with inflation targets of more than 3% have attempted further disinflation.
Source: FJMRS (2000) extended by the authors.

The distinction between an explicit inflation target or a published inflation assumption may also be fuzzy. Here, we rely on central banks' responses to the question 'Do you have a specific, numerical, publicly announced target for prices or inflation?' We consider this to be an objective question and differences in flexibility of the use of targets across countries, and in other framework characteristics may be measured by other questions in the FJMRS survey.

It is even more striking that the number of central banks implementing low and stable inflation targets[13] is very small relative to those implementing them during disinflations. In 2000, over 80% of countries using inflation targets were doing so when inflation was not low and stable (Table 2). The literature on the applicability of inflation targets in such economies has also grown. A number of papers focus on country experiences.[14] Others draw lessons from cross-country comparisons[15] and some papers highlight particular issues in the transmission mechanism that affect the use of inflation targeters outside the context of industrialised economies.[16] The papers by Mishkin and Schmidt-Hebbel (2002), and Sterne (2002) discuss specific policy issues involved in using inflation targets during disinflation.

---

[13] We define a country to be using an inflation target is low and stable when the inflation target is no more than 3%. This definition is appropriate in practice, since there are extremely few if any examples of countries that target inflation to remain steady and consistently above 3%, and there are also very few countries that have increased the inflation target once it is reduced to 3% or less. The only four examples of target increases at such low inflation rates are (i) Korea in 2000 (2% -4% to 1.5% -6%); (ii) New Zealand in 1997 (0% -2% to 0% -3%); Switzerland in 1995 (2.75% from 2%); and (iv) Taiwan in 2000 (1.7% from 1.6%).

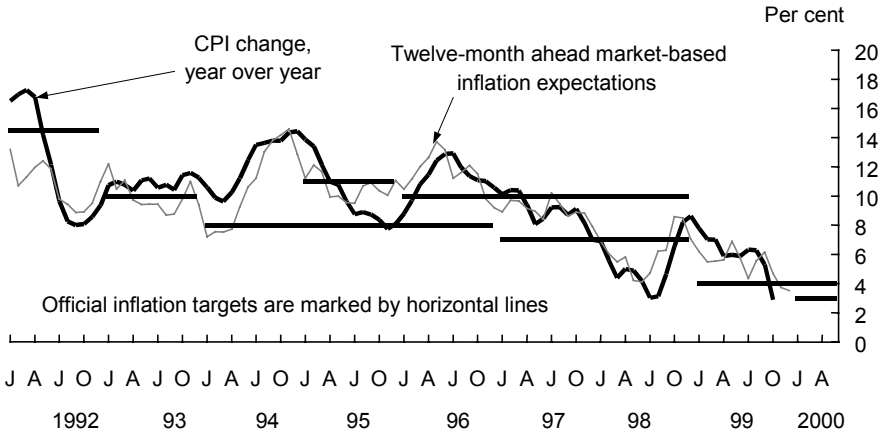
[14] For example, Landerretche, Morande and Schmidt-Hebbel ((2000) Chile), Bufman and Leiderman ((2000) Israel), Hrnčíř and Šmidkova ((2000) Czech Republic), Blejer *et al* (2000).

[15] Schaechter, Stone and Zelmer (2000), Mahadeva and Šmidkova (2000), Corbo, Landerretche and Schmidt-Hebbel (2002), Sterne (2002).

[16] See, for example, Mahadeva and Šmidkova (2000), Eichengreen (2001).

The Israeli experience of disinflating using inflation targets provides a pertinent example of the issues tackled in our paper. At the start of its bumpy disinflation path in the 1990s, the Bank of Israel announced inflation targets.[17] Chart A, taken from Bufman and Leiderman (2000), shows that there were several episodes in which the rate of inflation significantly deviated from its target at that time. But Chart A also reveals that these inflation targets were not abandoned altogether, but merely revised. Targets were frequently missed, but on average they were hit: the average annual rate of inflation from 1992 to 1999 was 8.9% which was close to the average annual inflation target of 9%. There were four misses where the rate of inflation increased well above the target. In these cases, the credibility of the regime was challenged by an escalation of inflation expectations. Only in one case, 1994, did a target overshoot result in an upward revision of the target. There were also two significant target undershoots (1992 and 1998). In both these cases the target was adjusted downwards markedly. Later on we suggest that the greater number of downward revisions need not reflect an asymmetric bias in policy, but more simply that the (often implicit) long-run target is much lower than the initial condition of high inflation. Then short-run targets, used flexibly, are always more likely to be revised downwards towards the long-run goal. Bufman and Leiderman (*op cit*) provide a more detailed consideration of each of the shocks, and their arguments reinforce the view that the policy of revising or defending a target was shock-dependent.

Chart A: Inflation, inflation expectations and inflation targets in Israel



Source: Bufman and Leiderman (*op cit*).

4 State-contingent inflation forecasts and targets

Many inflation targets have been implemented with the proviso that the probability of delivering low inflation in each year is conditional upon the absence of unusual circumstances that might lead to significant deviations from the long-run target. Formally, an inflation target set at time t may therefore be defined as being state-contingent when there is a significant probability that it will be revised at time $t+N$ to reflect changes in economic conditions that occur between t and $t+N$.

[17] We note that similar issues arise in the history of the disinflations of other countries which announced inflation targets. See, for example, Hrnčíř and Smidkova (2000) for the Czech story.

We argue that revisions to the targeted path during disinflations are almost inevitable and that a central bank operating in such circumstances is likely to endure more volatility than its low inflation counterparts.[18] In such circumstances policy-makers may be using a 'rule' for revising targets as well as a 'rule' for revising interest rates. But can a central bank still gain credibility by announcing a target that may be missed and later revised? We argue here the answer is 'yes', so long as the conditions under which that target might be expected to be revised are compatible with the long-run goal of price stability.

A state-contingent inflation target may be useful when a combination of three circumstances hold (see Figure 1):

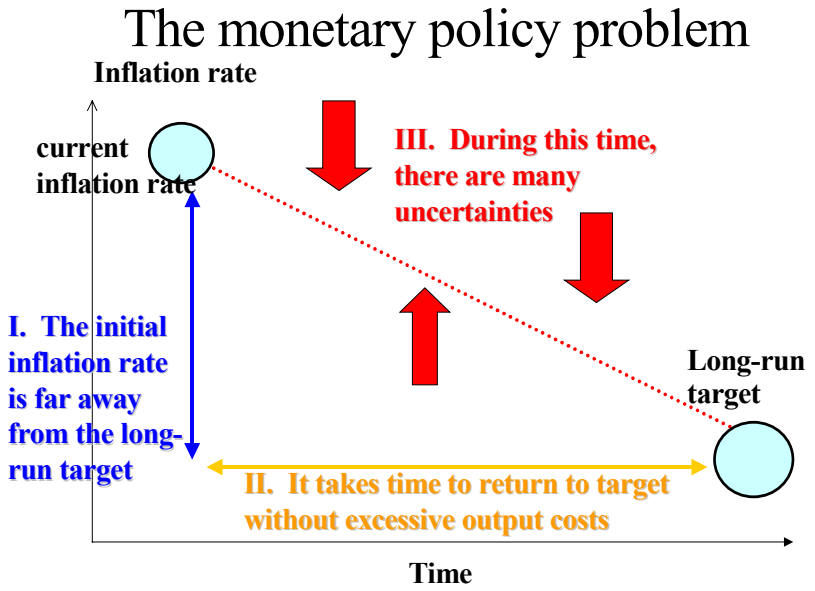
a) the current inflation rate is markedly different to the long-run target;

b) the output costs of moving to the long-run inflation target within a year or two years are expected to be large; and

c) the short-run behaviour is driven by many large and uncertain developments.

Some or all of these characteristics are familiar to most countries using inflation targets. In some circumstances it may be possible to achieve rapid disinflations without incurring significant output costs, if for example, inflation expectations adjust very quickly to a policy announcement as in Sargent (1999). But for most countries the monetary authority may have to tread gingerly towards achieving its inflation target, since rapid deflations can be achieved only at the expense of significant output costs stemming from nominal rigidities. The real short-run output costs of changing interest rates are amplified when there are large real rigidities (Ball and Romer (1991)).

Figure 1



[18] Noise may be present in the inflation rates of each of low and high-inflation economies, yet evidence generally suggests that it is typically higher in high-inflation economies. FJMRS (2000), for example, demonstrate that stable periods of inflation are much more common when inflation is less than 3.8%.

If the inflationary process were predictable, then it would be possible to engineer a disinflation by pre-announcing and committing to a target *path*. In practice, however, prevailing conditions rarely allow costless disinflations. Very open economies, for example, may be sensitive to foreign price shocks and non-policy related exchange rate shocks (eg Czech Republic). Similarly, there are countries whose inflation profile is dominated by unforeseeable productivity shocks, such as weather conditions. Supply-side shocks are not only very difficult to measure, but incorrectly reacting to them can also lead to substantial output losses.[19] Furthermore, the uncertainty that is frequently inherent in the disinflation process makes it unlikely that a commitment to a target path will be fulfilled *ex post*. The conditions under which a revision takes place and the central bank's commitment to explain these conditions then become crucial for credibility.

4.1 A theoretical interpretation

The benefits of short-run inflation targets may be deduced from their widespread use, yet in this section we demonstrate that it is not straightforward to provide a theoretical interpretation of their use in conjunction with long-run targets. We base our discussion on a simple model – developed in Appendix 1 – to examine the circumstances in which the short-run target is revised, and to question the extent to which it is possible to justify on theoretical grounds an active role for a short-run target in influencing economic outcomes. In the model we specify the central bank's loss function to include distinctly misses from each of the short and long-run target. Yet outcomes for inflation and output are not significantly affected by the addition of the short-run target. And we find that the short-run target is revised according to a simple forecasting rule that tracks the path back to price stability as defined by the long-run target. The target is revised in accordance with the shocks endured along the way to the long-run target and has no role in influencing inflation outcomes.

In this section we outline the key features and results of the model, discuss its implications and assess how the model might need to be modified in order to provide a more active role for short-run targets in influencing outcomes. The model, described in detail in Appendix 1 is a very simple, standard one, similar to those used by Bean (1998), Clarida *et al* (1999) and Cecchetti (2001).[20] It cuts the transmission mechanism for a closed economy to just two equations: aggregate demand and aggregate supply. The central bank's ability to measure demand and supply shocks is imperfect, giving rise to control errors, while the public's knowledge of the shocks is not as full as the central bank's, so there are also transparency errors. As in Blinder (1998, 2000), King (1996) and Clarida *et al* (*op cit*), no average bias exists in the central bank's preferences towards a positive output gap. Our interpretation of the use of short-run targets during disinflation is that they appear in the central bank's loss function *in addition* to the long-run objective and we illustrate the consequences of adopting such a pricing strategy.

The central bank knows of the demand and supply shocks only with some control error, reflecting the central bank's imperfect knowledge of both the transmission mechanism and the underlying shocks. However, what the central bank knows, and what the public knows may differ. This

[19] There are of course some supply-side shocks such as changes in administered price that may be easier to predict.
[20] For a model with more micro foundations, see Clarida, Galí and Gertler (2001).

gives rise to another source of uncertainty to the public – transparency errors – as in Faust and Svensson (1999). We crucially assume that both parties form rational expectations based on the information sets available to them. This assumes that the learning process about these shocks has converged. The transparency errors and the control errors are white noise disturbance terms, with a known variance. The demand shock, its transparency error and its control error must be uncorrelated with each other, as must the supply shock, its transparency error and its control error. Another important assumption is that the long-run objectives of the central bank – its target for the output gap and the long-run rate of inflation – and the weight that it places on them are fully known by the public.[21]

In order to examine the role for short-run targets we follow, for example, Walsh (1999), in adapting the standard model to allow the central bank to publish a short-term target that can be revised. The standard theory is extended to capture the concept of a short-run target in as simple a manner as possible; we employ the following central bank loss function reproduced from equation **(A4)** in Appendix 1:[22]

$$\sum_{s=0}^{\infty} L_{t+s} = 0.5 \sum_{s=0}^{\infty} E_t \left[\left(y_{t+s} \right)^2 + \lambda_1 \left(\pi_{t+s} - \pi^t_{St+s} \right)^2 + \lambda_2 \left(\pi_{t+s} - \pi_L \right)^2 \Big/ I_{cb} \right] \qquad \textbf{(1)}$$

where $y_{t+s,}$ π_{t+s} and, π^t_{St+s} are the output gap, inflation and the short-run target at time $t+s$, π_L is the long-run inflation target and $E_t \lfloor z / I_{cb} \rfloor$ denotes expectations of z conditional on the central bank's information set.

We note two key aspects of such a loss function. First, the specification stipulates that the central bank is penalised for deviating from a pre-set short-term target path ($\pi^t_{St}, ..., \pi^t_{S\infty}$) (Walsh (1998, chapter 8)) as well as from the optimal rate of inflation. This is a flexible-targeting rule, in that the central bank can trade-off missing this target with other objectives, including the long-run inflation goal. That deviations of inflation from a preannounced target enter into the central bank loss function whereas it does not enter into the public's social welfare function, reflects the fact that legislation may be responsible for determining the central bank's preferences.

A second adaptation is that this short-term target path is state-contingent and therefore may be revised in the future: π^t_{St+s} does not necessarily equal π^{t+q}_{St+s} for all $q = 1, ..., s$, as in Walsh (1999). In most models where an inflation target is preannounced, the target rate (either a scalar value set forever or even a path) is fixed. In this set-up, the central bank cannot commit to the short-run target path; instead the path can be continually revised *ex post* as the economy develops. Unlike

---

[21] Eijffinger, Hoeberichts and Schaling (2000) discuss what would happen if there were uncertainty about the weight placed on inflation stabilisation compared to output stabilisation by the central bank, and show that the volatility of inflation increases with this 'monetary policy uncertainty'. Uncertainty in the long-run objectives would also add to the volatility of output and inflation. One way this can be interpreted is that the central bank is not being fully transparent about its objectives - for example by not publishing a long-run inflation target. But if these long-run targets were subject to shocks about which neither the central bank nor the public have full information on, the shocks could reflect uncertainty in the underlying optimal rates of the inflation and potential output. For example, uncertainty in the optimal rate of inflation could arise from price measurement bias (Clarida *et al (op cit)*; Boskin *et al* (1998)). In this case the volatility in inflation and output could be welfare-enhancing.

[22] Our results may be different if we used a loss function where the penalty for deviating from the short-run target is not linearly independent of the penalty from deviating form the short-run target.

Walsh (1999), there are two targets announced. It is important to stress there is no conflict between these targets. A hierarchy is clearly established because as we show in Appendix 1, the short-run target is set conditional on the long-run target (as well as the central bank's preferences; and its and the public's, admittedly imperfect, knowledge of the transmission mechanism).

In Appendix 1, we derive the rule by which the central bank would set the short-run target, given values for λ_1 and λ_2, and for the special case that there is no inflation stickiness. We assume that the central bank cannot commit to any rule, and the solution under discretion implies that the short-run inflation target can be predicted according to a simple forecasting rule (equation **(A12)**). As such inflation depends fully on the long-run target, and it also depends on the supply shocks that are hitting the economy and the control and transparency errors associated with these shocks.[23]

$$E_t\left[\pi_t / I_{pub}\right] = \pi_L + \frac{\left(s_t'' - s_t'\right)}{c^2\lambda_2} + \frac{\left(s_t' - s_t\right)}{c^2\lambda_2} + \frac{s_t}{c^2\lambda_2} \qquad \textbf{(2)}$$

$$\pi_{St}^t = \pi_L + \frac{\left(s_t' - s_t\right)}{c^2\lambda_2} + \frac{s_t}{c^2\lambda_2} \qquad \textbf{(3)}$$

where the *control* errors and transparency errors in supply are written as $s_t - s_t'$ and $s_t' - s_t''$ respectively. Equations **(2)** and **(3)** are the final solutions for the public's expectations of inflation and for the state-contingent short-run inflation target. The short-run target deviates from the public's expectations of inflation only because of transparency errors in supply. If information sets are symmetric, and the public were able to process information as well as the central bank, then the short-run target would be equal to public's inflation expectations. This does not imply indeterminacy, as discussed by Bernanke and Woodford (1997), because both are conditional on, and therefore anchored by, the long-run target.

In this set-up, the central bank wants to improve its understanding of the transmission mechanism. Imperfect measurement of the demand and supply shocks by the central bank and public-control errors create further volatility in the output gap as well as inflation. Control errors about supply shocks affect inflation through excess output volatility and unstable inflation expectations. Fuzziness surrounding demand shocks feeds through to inflation via output only.

Here, transparency errors in supply, but not those in demand, also add to volatility. In this simple model, transparency errors in demand are not important for either inflation or output, because the central bank is able to offset the impact of these shocks on both output and inflation simultaneously with a flexible inflation process. It does not matter whether or not the public is made aware of this.[24] Transparency errors in supply do matter, however. Because supply shocks drive inflation and the output gap in opposite directions, the central bank is unable to achieve its

[23] In a more realistic model, the central bank would have to identify the supply and demand shocks, and their associated transparency errors, from an imperfect dataset on macro economic variables such as output and inflation, and measures of agent's expectations (see, for example, Svensson (2001, page 80) and Aoki (2002)).
[24] When inflation is sticky, transparency errors in demand will be important for both output and inflation.

goals for both inflation and output by either raising or cutting interest rates. The less the public know about supply shocks, the more unstable inflation expectations become and the more active real interest rates must be.

Given the assumptions underlying our simple framework, it follows that the central bank would always choose to reduce such errors where possible. The elasticity of a given transparency error on inflation and output depends on how sticky prices are and the real costs of this price stickiness – it diminishes with the parameter *c* (see Appendix 1). It is also true that the effect of a given transparency error on inflation and output also falls with the weight placed on the long-run target – it depends inversely on the parameter λ_2.

In the case when the economy is hit by shocks whose cause and effects are more easily explained and costly to offset – imported price changes, weather conditions, government price changes, indirect tax movements – the model points to the potential benefits from explaining policies in order to limit transparency errors rather than revising the short-term target.

To summarise, our simple model suggests that short-run target path is akin to a *state-contingent* forecast that the central bank preannounces at each time *t* (Svensson (2001)) and that the short-run target may be predicted given information about the long-run target and full knowledge about shocks hitting the economy. As it is the central bank's state-contingent forecasted path for inflation, the short-run target may deviate from the long-run target run because of the threat of output losses. But it will eventually converge to the long-run target within a long enough horizon.[25]

5 Inflation targets and forecasting rules: an empirical examination

5.1 Relating the theory to our estimated equations

We wish to determine in our empirical analysis the extent to which short-run targets can be predicted using a simple forecasting rule linking them to inflation and to the long-run target. A limitation of our theoretical model, however, is that the framework cannot be used to directly infer the equation we wish to estimate: the absence of dynamic terms in the Phillip's curve (see appendix equation **(A2)**) implies that lagged inflation does not appear to affect target revisions. A more realistic model would be needed to describe our data and it would have to feature sticky inflation and not just sticky prices. Models with a role for lagged inflation (eg Bean (1998) and Clarida *et al*, *op cit*) or with a role for expected future inflation (eg Jensen (2000)) can lead to results different to ours. In particular, it seems plausible that we would have to adapt the simple rule for the short-run target, to allow the short-run target to be also determined by past inflation as well as the long-run target.

---

[25] In the solution to this simple model, the announced target path will always equal the central bank's rational expectation of inflation, given its information set: $\pi^{t}_{St+s} = E_t\left[\pi_{t+s} / I_{cb}\right]$, as there is no gain to not being fully transparent.

But within our framework a more complicated model cannot easily be solved analytically, even in models that do not include both a short and long-run target (Clarida *et al*, *op cit*). To derive the functional form that we estimate, therefore, we have to guess the form that the rule for the short-term inflation target would take if inflation is sticky ($0 < \alpha < 1$ in appendix equation **(A2)**). As the model is still homogenous in its nominal variables, the rational expectation of inflation formed by the public would most likely be a weighted average of past inflation and the long-run target, and also a function of the current shocks as well as the expectations of future shocks.[(26)] The short-term inflation target would only differ from this expectation because of transparency errors. This would suggest that a rule of the following form would be appropriate:

$$\pi_{St}^{t} = \phi\pi_{L} + (1-\phi)\pi_{t-1} + \text{shocks} \qquad \textbf{(4)}$$

where $0 < \phi < 1$.

According to equation **(4)**, the short-run target at time *t*, π_{St}^{t}, is now endogenous to past inflation as well as the long-run target. Therefore the short-run target will deviate from the long-run target, not only depending on a) where past inflation is but also on b) what shocks are hitting the economy.

Some simple manipulation enables us to re-write equation **(4)** in error-correction-mechanism form to give us the model that we estimate:

$$\pi_{St} = \pi_{St-1} - (\pi_{St-1} - \pi_{t-1}) + \phi(\pi_{L} - \pi_{t-1}) + \text{shocks} \qquad \textbf{(5)}$$

Equation **(5)** posits that the revision to the short-run target (forecast) each period will be in line with the miss from the last period's short-run target (forecast) and will also depend linearly on the miss from the long-run target.[(27)] The empirical tests we conduct therefore focus upon how the targeted path of inflation may be endogenous to macroeconomic outcomes, and in particular to the misses from the short and long-run inflation targets.

5.2 Data

The dataset we use is unique in its comprehensive coverage of the global use of inflation targets in the 1990s. It includes 318 annual observations of inflation targets and outcomes, starting in 1980. The data represent an unbalanced panel; within the 56 countries, the number of annual observations ranges between 1 and 11. The data are presented in full in Appendix 2. The questions asked were as follows:[(28)]

[(26)] With inflation sticky, demand shocks and their associated errors are now also important in affecting the short-run target.

[(27)] Only a minority of those disinflating countries specifying annual inflation targets also express explicit numerical long-run targets. However, over 95% of countries in our sample have specific reference to monetary or price stability in their statutory objectives, so we believe our analysis is appropriate whether or not such an explicit long-run target exists.

[(28)] Taken from Mahadeva and Sterne (2000, page 167). The authors re-surveyed central banks to gather data for 1999 and 2000.

- Do you have a specific, numerical, publicly announced target for prices or inflation at the present time? **Yes/No**
- Is it a point target or a range? What reasons have you provided for this choice?
- Did you have such a target in other years in the 1990s? **Yes/No**
- What has been the target in other years in the 1990s? How does this compare with the outcome?

	Target for Current Year	**Outcome**
1990		
1991		
1992		
1993		
1994		
1995		
1996		
1997		
1998		
1999		
2000		

5.3 Empirical results

Our analysis covers three aspects of target use. First, we shall examine the extent of target misses to draw conclusions about the accuracy and flexibility with which targets are implemented. Second, we assess the way in which annual targets have been revised and use panel regressions to provide information on the extent to which target misses influence the future path of inflation targets?

5.4 Summary statistics and stylised facts

5.4.1 Target misses

To the extent that unexpected shocks even out over the sample period, Table 3 suggests that the median policy-maker has shown little bias in meeting the short-run inflation targets. The first column of Table 3 illustrates that in the overall sample, there is no significant evidence that inflation outcomes overshoot or undershoot the short-run target on average. The median miss is an undershoot of just under 0.1 percentage points.[(29)] There is, however, evidence that misses are strongly skewed such that upside misses have been relatively larger; the mean miss is 3.7, compared to the median miss of –0.1. Columns (2) to (6) of Table 3 divide the sample into five groups, according to the size of the target. The results illustrate that countries with higher short-run inflation targets are relatively more likely to overshoot their target. For countries with targets less than 2.5 percentage points, the median absolute miss is just 0.5 percentage points (column (2)). In contrast, the median absolute miss for countries setting high inflation targets of over 15 percentage points is 6.4 percentage points.

[(29)] Some of these targets are ceilings, so a marginal undershoot may not be indicative of systematic target undershooting. Another data problem is that some targets are expressed as year-end, while others are annual average.

Table 3: Inflation target misses at different magnitudes of inflation targets

Average target (T)	(1) All*	(2) T <=2.5 (very low)	(3) 2.5 <T<= 4.5 (low)	(4) 4.5<T<=8 (medium)	(5) 8<T<=15 (high)	(6) Above 15 (very high)
Observations	318	71	59	65	60	63
25th percentile miss	-1.2	-0.7	-1.2	-1.5	-1.25	-3.2
Median miss	-0.08	-0.3	-0.1	0.3	.25	1.5
75th percentile miss	1.7	0.4	0.62	2.1	3.56	8.1
Median absolute miss	1.4	0.50	0.94	1.8	1.8	6.4
Mean	3.7	-0.16	-.32	.77	1.6	4.7
Standard deviation	6.4	2.0	2.0	4.9	9.3	13.7

The median target for all countries with inflation targets is 6%. For 'inflation targeters' it is 2.75%.

Inflation targeting has been characterised as 'constrained discretion'[30] and 'a framework not a rule.' Table 3 shows that the median absolute target miss is 1.4 percentage points, and that the magnitude of misses remains roughly in proportion to the level of the target. We are unable to determine from these data the exact extent to which misses are attributable to less than 100% rigidity in attempts to hit targets, or because the lengthy transmission lags imply that policy-makers are unable to restore inflation back to target within an annual horizon. To be more precise about the extent to which policy reacts to deviations from inflation targets we would need to estimate accurate Taylor rules for countries pursing disinflation. Existing attempts to identify Taylor rules in disinflating economies using inflation targets have met with mixed results.[31] Our data are nevertheless consistent with a flexible approach to the use of inflation targets at higher targeted rates of inflation.

5.4.2 Explaining target revisions according to a 'forecasting rule'

Our annual data on target revisions illustrate the widespread use of inflation targets during a period in which inflation has fallen in many economies (Table 4). During the 1990s, annual inflation targets have been much more frequently revised down than up; in the sample as a whole only 14% of the 274 observations represented upward revisions. When targets were 4.5% or less, upward revisions were very rare, representing just 5% of observations. The median absolute revision in our sample is 0.7 percentage points, with the size of the revision increasing roughly in proportion to the magnitude of the previous period's target.

[30] Bernanke, Laubach, Mishkin and Posen (*op cit*).

[31] Corbo *et al* (2002) find significant evidence that policy reacts to deviations from the inflation target in 50% of the six disinflating countries for whom they estimate Taylor rules. This percentage is slightly higher than for other inflation targeting countries in the sample, and also higher than for non-inflation targeting countries. The authors argue that in some disinflating economies (Chile and Israel) policy-makers have to react more strongly to changes in the earlier stages of disinflation when the importance of establishing credibility is higher.

Table 4: Inflation target revision at different magnitudes of inflation targets

Average target (T)	(a) All*	(b) T <=2.5 (very low)	(c) 2.5 <T<= 4.5 (low)	(d) 4.5<T<=8 (medium)	(e) 8<T<=12 (high)	(f) Above 12 (very high)
Observations	270	63	45	62	47	53
10th percentile revision	-6	-0.5	-2	-4.5	-7.7	-10.7
25th percentile revision	-2	0	-0.8	-2.0	-5.0	-6.0
Median revision	0	0	0	-1.0	-.75	-1.0
75th percentile revision	0	0	0	0	0	0
90th percentile revision	0.8	0	0.25	0.8	1	6.5
Median absolute revision	0.7	0	0.2	1.3	1.2	4.0
Mean	-1.4	-0.11	-1.17	-1.5	-3.1	-1.5
Standard deviation	5.3	0.32	4.0	2.6	6.7	8.9

The median target for all countries with inflation targets is 6%. For 'inflation targeters' it is 2.75%.

Our data suggest that inflation targets are frequently missed and frequently revised yet have been dropped extremely rarely. These stylised facts are consistent with the view that one of the reasons that inflation targets have proven so durable to many types of economic shocks is that they can be used relatively flexibly without necessarily undermining credibility of the framework. The corollary of inflation targets not usually being used as a strict rule is that missing them does not generally break any rules. Competent economic policy may improve credibility even if the target is missed, as long as the miss is consistent with striking an appropriate balance between reacting to shocks and maintaining price stability in the long run.

An important objective of our empirical analysis is to relate target revisions to the size of target misses so that we may then draw out implications for institutional design of monetary frameworks. In particular we seek to show how the change in inflation targets on a disinflationary path may itself be endogenous to inflation outcomes; we aim to investigate if target revisions can on average be predicted according to a simple forecasting rule whereby the target revision depends upon the extent to which last period's inflation deviated from each of the short and long-run target.

By way of introduction, Table 5 provides simple correlation coefficients between the annual target revision and last year's miss. There is a strong correlation between the lagged miss and the change in the target. Column 1 shows that for the entire sample of 274 observations, the correlation coefficient is 0.73. The table therefore suggests that target-setting and inflation outcomes are endogenous. Columns (2) and (3) illustrate that target revisions are much more strongly correlated with last period's miss when inflation was below target, than when it was above it. The contrast between the two scenarios is stark. When inflation is below target, the revision to the target is very highly correlated with the miss. In contrast, when inflation is above target, the target revision is significantly *negatively* correlated with the target miss. The results are similar, though less strong, for 'inflation targeters' (lower row of the table). We reserve our detailed policy interpretation for Section 5 below; here we merely note that we find the results consistent with sensible, pragmatic policy-making.

Table 5: Correlation between change in the target and last period's miss?

Correlation coefficients	(1) All countries	(2) When inflation below target	(3) When inflation above target
For all inflation targets	0.73	0.98	-0.36
(number of observations)	(274)	(137)	(135)
For 'inflation targeters'	0.32	0.52	0.19
(number of observations)	(80)	(45)	(34)

The results from our panel estimates shed light on the simple correlations. We run four regressions that explain revisions to short-term targets by the degree to which short and long-term targets were missed in the previous period. Below are two general equations that differ only insofar as the second one allows for asymmetric responses to misses that are above and below the short-term target. The four equations we estimate are variants of these two equations:

$$TS_{it} - TS_{it-1} = \alpha_1(\pi_{it-1} - TS_{it-1}) + \alpha_2(\pi_{it-1} - TL_i) + \varepsilon_{it}$$

or:

$$TS_{it} - TS_{it-1} = \alpha_3(D1^*(\pi_{it-1} - TS_{it-1})) + \alpha_4(D2^*(\pi_{it-1} - TS_{it-1}) + \alpha_2(\pi_{it-1} - TL_i) + \varepsilon_{it}$$

where:

TS_{it} is the short-run inflation target (the annual target in country i, set at time t, set at t-1).

TL_i is the long-run inflation target (the annual target in country i). For convenience TL_i is assumed to be zero, though an alternative assumption would make no difference other than to the constant term in the regression.

π_{it} is the inflation rate in country i at time t, a proxy for the deviation from the long-run target.

ε_{it} is the error term.

D1 is a dummy that is 1 if the target miss was negative in the last period.

D2 is a dummy that is 1 if the target miss was positive in the last period.

Equation **(5)** above predicts that the estimated equations would satisfy a number of coefficient restrictions as follows:

Prediction i: $\alpha_3 > \alpha_4$ when the miss from the long-run target is excluded from the regression.

If the miss from the long-run target is excluded in the regression, the reaction to a target undershoot (α_3) will appear to be stronger than to a target overshoot (α_4). In the case of an overshoot, the policy-maker would tend to revise the target up, towards the positive miss, but this will be offset by the tendency to revise the target down towards the miss from the long-run target. So α_4 could take a negative value. In the case of an undershoot, the policy-maker will revise the target down towards the short-run target and this will be reinforced by the tendency to also revised the target down towards the long-run target.

Prediction ii: $\alpha_3 = \alpha_4$ when the miss from the long-run target is included in the regression.

As long as the miss from the long-run target is included in the estimated equation, the target will be revised in line with the miss from the short-run target irrespective of whether the short-run target is missed on the upside or downside.

Prediction iii: $\alpha_1 = 1$ and $-1 \le \alpha_2 \le 0$ when the misses from each of the long and short-run target are included.

The annual target will be revised in line with the miss from last year's target ($\alpha_1 = 1$) while the target revision will also depend upon how far is inflation from price stability.

5.5 Discussion of econometric results

Table 6 shows results from panel regressions using all 274 usable annual observations in the sample. The diagnostic results are satisfactory (see Table 6 and footnote 33). The R^2 is generally much higher than is frequently the case in panel regressions, owing in part to the narrowness of the hypothesis we test; the R^2 ranges between 0.50 and 0.95 for the whole sample, and between 0.10 and 0.61 for the smaller sample of 'inflation targeters'. In each of Tables 6 (results for all countries) and 7 (results for 'inflation targeters') our preferred regression is the final one (regressions 4 and 8). We describe the other results as they are building blocks to our preferred ones.

Table 6: Panel estimates: how targets are revised following target misses[32]
All countries: Fixed-effects regression, t-statistics in brackets

Dependent variable: Change in the inflation target from previous year				
	Regression 1	Regression 2	Regression 3	**Regression 4**
α_1: Miss from short-term target last period	1.36			**0.95**
	(21.5)			**(44.2)**
α_3: Miss from short-term target last period x below-target dummy D1		1.74	0.911	
		(41.1)	(22.8)	
α_4: Miss from short-term target last period x above-target dummy D2		-0.311	1.02	
		(-3.4)	(14.2)	
α_2: Miss from long-run target			-0.79	**-0.76**
			(-24.1)	**(-45.9)**
Constant	-4.7	0.77	5.7	**5.6**
	(-6.1)	(1.43)	(16.7)	**(17.1)**
R^2 (overall)	0.54	0.88	0.95	**0.95**
F-stat	463.3	845	2356	**3533**
F-test for poolability	4.0	1.88	4.0	**4.1**
Chi^2 for coefficient restriction $\alpha_3 = \alpha_4$		845 (p=0.00)	1.1 (p=0.30)	
Chi^2 Hausman test for fixed effects versus random-effects model*	73.1	4.07	12.3	**8.2**
Number of observations	274	274	274	**274**

* The results were similar when we used random effects regressions, though in all cases the Hausman test rejected.

[32] In all cases the Hausman tests favours using fixed effects over random effects regressions. Most panel studies do not report tests of serial correlation because the tests may adopt the implausible alternative that the serial correlation is homogenous across data groupings. Our preferred regression nevertheless marginally fails the LM and LM(5) tests reported by Baltagi (1995, page 91) for first-order serial correlation in a fixed-effects model. When we estimated the fixed-effects model to allow for first order serially correlation in the errors, the coefficients on the misses from the short and long-term target each changed by less than 0.03. The serial correlation could arise from a missing lagged dependent variable that in our model could arise from persistence in target-setting. But when we estimated a dynamic panel, including last year's target revision as a regressor, using the Arellano and Bond (1991) GMM method adjusted for robust standard errors, the lagged dependent variable is insignificant at the 95% level. And the estimates of the other coefficients do not change much. We also note that **(5)** shows that the model is dynamic and potentially susceptible to the dynamic panel bias with heterogeneous parameters discussed by Pesaran and Smith (1995). However, as the equation parameters other than the fixed effects are evidently homogenous, this source of bias is not an issue. And in any case, the short sample periods would not allow their methodology to be used. As the serial correlation could arise from autocorrelated residuals - supply shocks that are correlated and repeatedly ignored by the target-setters - we also carried GLS estimations with a first-order autocorrelation process that differs across countries: the estimates of the other coefficients were virtually unchanged. Finally, the coefficients were also virtually unchanged when we used hetereoskedastic consistent errors.

The first regression confirms the target revision depends strongly upon last period's target miss, and that targets are revised in the direction of last period's miss. The strongly significant coefficient of 1.36 suggests that when targets are missed, the target is revised by more than the miss.

Regression 2 confirms that there exists an asymmetric response of target revisions to misses depending upon whether the short-run target was undershot or overshot in the last period. We find that the target is revised down very strongly following target undershoots, yet it is still revised down, albeit weakly, following target overshoots. We tested for the asymmetry by splitting in two the short-run-target-miss variable. The first multiplies the lagged miss by a dummy (D1) that is set to one when the target was undershot, and zero otherwise. The second equals one when the target is overshot, and zero otherwise. The results markedly increase R^2 and suggest a very marked asymmetry, with the coefficient on the multiplicative dummies being 1.74 when the target is undershot, and -0.31 when it is overshot. Prediction *i* above is therefore confirmed to hold.

Regression 3 illustrates that inclusion of the lagged inflation rate as a proxy for deviations from the long-run target eliminates the apparent asymmetries in the way target revisions react to upside and downside misses. Coefficient restriction tests on the target-miss terms (tests of $\alpha_3 = \alpha_4$) cannot reject the null hypothesis that they are the same. Prediction ii from above also holds. The apparent asymmetric reaction is merely indicative of a significant weight being attached to an explicit or implicit long-run target.

Regression 4 (our preferred regression) imposes symmetry in the reaction to missing above and below the short-term target ($\alpha_3 = \alpha_4$). The expected results holds: the extent to which the target is revised down depends upon the target misses from both the short and long-run target. The coefficients are broadly consistent with our predictions: the coefficient on the miss from the short-run target is positive and close to unity; missing the short-term target leads to a revision in the direction of the miss. Our predictions suggested $\alpha_1 = 1$. This is close to our estimate of 0.95, but the difference is significant at the 95% level. We suggest that the significant difference stems from the fact that we include in our sample are a number of low-inflation countries that never change their short-run target, thus reducing the overall sensitivity of the sample to target misses. The coefficient on the miss from the long-run target is negative, consistent with the prediction that $-1 \le \alpha_2 \le 0$: as long as inflation remains above the long-run target then this leads policy-makers to revise down next period's short-run inflation target. In short, the results are consistent with policy-makers in each year revising their short-run targets up or down almost in line the miss from last years' short-run target. And they also revise down the short-run target in proportion to the 'miss' from the long-run target of price stability.

Table 7 presents the results for the sub-group of 80 observations for 'inflation targeting' countries. The results are similar to those for the entire sample of observations, though the coefficients and t-statistics tend to be lower. The smaller impact of target misses on next year's target revision are unsurprising given that a large proportion of the group never revise the targets: in the sample of 80 observations, 35 represent those in which the target was reduced, 4 when it was increased and 41 when the target was not revised. There is some evidence of asymmetric

reactions to target misses in regression 2, though it is not significant. And in our preferred regression 8, the coefficients are correctly signed though the affect of the target miss is weaker than for the entire sample predicts.

Table 7: Panel estimates: how targets are revised following target misses: 'inflation targeters' only

Dependent variable: Change in the inflation target from previous year, fixed-effects regression, t-statistics in brackets

	Regression 5	Regression 6*	Regression 7**	**Regression 8****
A_1: Miss from short-term target last period	0.39 (3.7)			**0.52** **(8.4)**
A_3: Miss from short-term target last period x below-target dummy D1		0.48 (3.13)	0.65 (5.8)	
A_4: Miss from short-term target last period x above-target dummy D2		0.11 (0.78)	0.41 (4.0)	
A_2: Miss from long-run target			-2.6 (-9.6)	**-0.25** **(-10.1)**
Constant	-0.7 (-5.2)	-0.60 (-1.86)	0.21 (2.8)	**0.57** **(3.3)**
R^2 (overall)	0.10	0.16	0.62	**0.61**
F-stat	14.0		41.7	**60.8**
F-test for poolability on fixed effects regr.	2.86	1.88	1.12	**1.26**
Chi^2 for coefficient restriction $\alpha_3 = \alpha_4$		2.42 (p=0.12)	2.00 (p=0.16)	
Chi^2 Hausman test for fixed effects versus random-effects model*	3.02	2.18	n/a	**5.4**
Number of observations	80	80	80	**80**

* The Hausman test for regression 6 indicated a systematic difference using the random-effects regression, and these are the results we report, with z, rather than t-statistics in brackets. The results were similar whichever technique was used.

** Regressions 7and 8 are pooled estimates, as the F-tests on fixed-effects regression indicating pooling to be acceptable. The results were similar whichever technique was used. In regression 8 we also tested for the significance of the lagged dependent variable. It was insignificant at the 95% level.

In summary, in order to model the use of inflation targets during disinflation one would need to allow for the fact that policy-makers can be characterised as using two distinct rules. One is the familiar policy rule (Corbo *et al* (2002)), whereby interest rates are revised to restore inflation to target. The other is a target-setting rule along the lines estimated in this section, whereby the target may be revised periodically according to a 'forecasting' rule based upon misses both from the short-run and from the long-run target. We would suggest the rule be of the form suggested in equation **(5)** above, and could be enacted periodically depending upon institutional circumstances in the country concerned. More generally, the analysis points to the inseparability of the process of target and interest rate setting may be important factors in modelling disinflating economies, as they are in designing appropriate policy regimes, an issue we address in Section 6.

6 Implications for the choice of institutional framework

In this section we weave our results with those of others to draw some striking implications for the design of monetary frameworks that use inflation targets during disinflation, or when shocks cause relatively large departures from (declared or implicit) long-run inflation targets.

The first result policy implication stems directly from our empirical analysis:

- **During disinflation inflation 'targets' may be predicted according to a state-contingent forecasting rule, so it is harder to separate decisions regarding the 'target' from that of instrument setting: it is therefore more complicated to design any monetary strategy that attempts to utilise distinctions between the roles of setting interest rates and those of setting the short-run target**

The scope of our analysis is insufficiently broad for us to advocate any particular combination of responsibilities for setting targets and instruments, but they do suggest that the inseparability of responsibilities for setting targets and instruments should be recognised in framework design during disinflation. During disinflation, in the months leading up to the announcement of the revised 'target', the decision about the future inflation target and about interest rates may be endogenous, in a similar fashion to the decision regarding setting interest rates and forecasting inflation. Such a blurring between objectives and implementation can translate directly to the challenge of designing unambiguous roles in monetary policy strategy for the principal (government) and its agent (the central bank). Government influence over revisions to a target to which the central bank must steer inflation may undermine central bank instrument independence. In a situation of relatively low and stable inflation such as in the United Kingdom, it has been possible for government to set the Bank of England's inflation target at 2.5% and keep it unchanged since it granted the Bank of England instrument independence to meet the target. In contrast, during disinflation government decisions (and expectations of them) to revise the target might immediately influence the setting of instruments. Approaches to inflation targeting based upon providing clear and distinct roles for government and the central bank in setting and implementing inflation targets (eg Walsh (1995)) are less practicable when using inflation targets on a disinflating path.

The results suggest practical limitations to the capacity of policy-makers to pre-commit to a disinflation path. The results are complementary to that implied by Lohmann (1992) who argues that it is impossible to commit to state-contingent policy rules since it is 'impossible or prohibitively costly to specify all possible contingencies in advance.' The implications of our results differ from Lohmann's insofar as she stresses the importance of allowing the policy-maker to overrule the delegated monetary authority in the case of extreme shocks, whereas we focus upon the implications for revising short-term targets caused by small or large deviations from the target. Lohmann's interpretation is relatively more appropriate for countries where shocks that cause significant potential deviations from target are relatively infrequent; ours is more applicable to the large number of countries that experience frequent shocks.[(33)]

We draw other policy implications by considering our results in conjunction with other work, particularly relating to that regarding the implications of central bank transparency:

[(33)] It has sometimes been argued that escape clauses should be circumstance-specific and specified *ex ante*, so that it is clear that the policy-maker is not 'breaking the rules'. Revisions to the target tend to be general and *ex post*. But in principle, revisions could be accompanied by a transparent explanation and could happen *ex ante*.

- **Short-run targets (or forecasts) may contribute to price stability even if they are more akin to forecasts than policy rules**

In this section we link our results to the recent literature on central bank transparency[34] to suggest reasons as to why the central bank should publish targets during disinflation. Transparency can result in lower inflation (eg Faust and Svensson (1999)), since it makes a central bank's reputation more sensitive to its actions and reduces any inflation bias. Introducing transparency may therefore prompt the central bank to implement low-inflation policies.[35] The limitations of our simple theoretical model imply that we have not so far considered such transparency mechanisms. In fact we have not demonstrated any benefits from using inflation targets. Although the information sets of the public and the central bank differ in the model, there is no feature that makes it interesting to explore why or why not there is a gain to the central bank, or society, from the publication of short-term targets. The central bank is fully credible in our model, whereas in practice, central banks, and especially those undertaking disinflation may lack credibility. By a lack of credibility, we mean that the public erroneously attaches some probability to the possibility that the central bank has an incentive to target a positive output gap (on average), and so to cheat the public with bursts of surprise inflation. As in, for example, Barro and Gordon (1983); Cukierman and Meltzer (1986); Cukierman (2000); Eijffinger, Hoeberichts and Schaling (2000); Faust and Svensson (1998, 1999); Jensen (2000) and Geraats (2001), the public has to learn that the central bank is of the type that does not have an inflationary bias.

Walsh (1999) shows that there could be benefits from publishing a pre-announced short-run inflation target under less than full credibility. In his model, the institutions are designed such that the central bank is penalised when inflation deviates from its state-contingent forecast and this provides an extra benchmark for the public to better distinguish the central bank's type. And as that target can be revised *ex ante* by the central bank itself, the regime provides some scope to act against short-run output losses, as a way of accommodating supply-side shocks. There may thus be some gain to society from making the central bank publish its short-run target.[36]

The theoretical literature considered in this section reaffirms our view that short-run targets are similar animals to state-contingent forecasts. If it were possible to set up an institutional design in which the central bank were required to publish its true state-contingent forecast then this should imply that the central bank cares to some extent about deviations of inflation from this forecast. In such a regime, the forecast is in effect an intermediate target, which sits alongside the long-term objectives in the central bank loss function.

The theoretical benefits from publishing forecasts and targets are supported by cross-country empirical evidence suggests that greater transparency is strongly associated with lower inflation

---

[34] See Geraats (2002) for a review of the transparency literature.

[35] Other assumptions may change the results of the model. For example, allowing for learning (King (1996); Faust and Svensson (1998, 1999) and Sargent (1999)) and uncertainty about parameters (Sack (1998), Hall *et al* (1999) and Srour (1999)).

[36] But it is not necessarily true that the best short-run target, from society's point of view, is the central bank's state-contingent forecast. There may be circumstances where output and inflation can become more volatile if the public co-ordinate their decisions around uncertain signals (Geraats (2002), Morris and Shin (2001)). And increased transparency is not inevitably good for output stabilisation (Cukierman (2000)) since it reduces the capacity to conduct surprise inflation.

(see Chortareas, Stasavage and Sterne (2001)). These authors also find that the effect is higher for countries with higher rates of inflation, since introducing transparency when credibility is low or inflation is high offers greater scope for credibility gains. During disinflation, inflation targets, particularly when accompanied by clear explanations of misses and target revisions, may therefore have a very important role to play in communication between the central bank, government and the private sector.

- **Short-term money and inflation targets need not necessarily be seen as alternatives during disinflation**

When targets are viewed as being more akin to state-contingent forecasts than rules, the case for viewing inflation and money targets as alternatives is undermined. Publishing forecasts for more than one variable may *increase* transparency by more than publishing only one target since publishing a forecast for more than one variable may better inform the public about the central bank's opinion regarding the source of the shock. Such an interpretation is opposed to a common interpretation of targets for different variables as being potentially colliding rules.

During disinflation we argue that there is a much stronger case for publishing state-contingent forecasts for both money and inflation. Our interpretation is consistent with the practice of central banks, contained in the striking results of FJMRS (2000), who show that in a sample on 93 economies each country on average uses explicit targets for 1.5 variables (where the variables include only the exchange rate, money and inflation). The data from FJMRS also show that disinflating central banks are less likely to publish detailed forecasts (including an assessment of risks) than their counterparts in low-inflation countries. For these countries in particular, publication of money and inflation targets may therefore be important in informing the public about the central banks knowledge of the economic developments.

- **There are no prerequisites for inflation targets, since they are more like state-contingent forecasts**

The results discussed here lead us to argue that there exist potential marginal benefits from increasing transparency through the introduction of inflation targets (or state-contingent forecasts), irrespective of the state of other monetary framework characteristics, such as central bank independence and fiscal dominance of monetary policy. This contrasts with previous literature that has argued that such prerequisites need to be in place before the introduction of inflation targets (eg Masson *et al* (1997)). Our results are consistent with the arguments of Sterne (2002), who argues that framework choices may evolve in a number of ways to meet particular circumstances and there is a risk that focusing on pre requisites to any particular framework may distract policy-makers from pursuing an optimal choice.

The transparency literature discussed above suggests that benefits comes through a reputational channel and, though the result in the theoretical literature is not so developed to encompass a wide variety of institutional circumstances, we would argue that in practice the importance of transparency in promoting reputational effects in policy-making can be very important in a wide array of circumstances and may be particularly strong when reputation has not yet been earned

(Chortareas *et al* (2001)). The argument against introducing inflation targets depends upon the view that missing them may severely undermine reputation, yet we find no evidence for this to be the case (Sterne (2002)). To the extent that the introduction of inflation targets may help secure the benefits of transparency, there may be strong reasons not to wait for other framework reform before they are introduced.

7 Conclusions

The rapid spread of inflation targets to disinflating countries was one of the most striking developments in monetary policy framework design in the 1990s. In this paper we have reconsidered the role of inflation targets during disinflation. Our results have suggested that short-term targets are more akin to state-contingent forecasts than policy rules. In common with a good forecast, short-term targets are met on average. If they are missed, however, then the target for next year is likely to be revised. In particular we have shown that target revisions are endogenous to the outcome for inflation in a way that is predictable. Optimising policy-makers who place some weight on long-term inflation objectives are more likely to revise the short-run target down if they undershoot the short-run target than if they overshoot it.[37] The main implication of this result is that during disinflations, there may exist two types of policy rules, one for revising targets, the other for setting interest rates.

In designing roles for the legislature and the central bank in the monetary framework it is necessary to take into account the likelihood that the process of setting and revising the target may in some circumstances be inseparable to that of setting policy instruments. Frameworks that utilise a clear distinction between the government's responsibility for setting the target and the central bank's for meeting it – such as the United Kingdom, where the government has maintained the inflation target at 2.5% every year since it delegated responsibility for meeting the target to an independent central bank – may be impracticable during disinflation.

Inflation targets may nevertheless provide a strong marginal contribution towards delivering price stability in disinflating economies. We have drawn on the growing literature on central bank transparency to argue this case. Publishing forecasts may make a central bank's reputation more sensitive to its actions and empirical evidence suggests that this channel is strongly significant in securing lower inflation outcomes.

We have drawn two further implications from our analysis, each of which collide with some commonly held views on the use of inflation targets during disinflation. First, it is not inevitable that money and inflation 'targets' are alternatives during disinflation, since we argue that publishing both may add to the transparency of the regime. Second, we have argued against the view the assumption that their exist pre requisites to publishing state-contingent forecasts for inflation during disinflation. There may be strong reasons for a central bank not to wait for other framework reform before announcing its intentions for inflation.

---

[37] Revisions to the target may also reflect other aspects of policy-makers' knowledge of the transmission mechanism, and their preferences with regard to the optimal trade-off between inflation and output stability, though this is beyond the scope of our paper.

Appendix 1: The model

The closed economy is summarised by an aggregate demand curve **(A1)** and an aggregate supply curve **(A2)**. In the aggregate demand equation, output (measured relative to its potential), y_t, is a function of the (policy-determined) real interest rate, r_t, and a demand-side shock, d_t:

$$y_t = -br_t + d_t \qquad \text{IS curve} \qquad \textbf{(A1)}$$

In the aggregate supply equation **(A2)**, inflation, π, is a function of the expectation of current inflation by the public based on their information sets, $E_t\left[\pi_t / I_{pub}\right]$, the output gap, y_t and a supply-side shock, s_t. $E_t\left[z/I_{pub}\right]$ denotes expectations of z conditional on the public's information set.

$$\pi_t = \alpha E_t\left[\pi_t / I_{pub}\right] + (1-\alpha)\pi_{t-1} + cy_t + s_t \qquad \textit{Phillips curve} \qquad \textbf{\textit{(A2)}}$$

where π is the inflation, $E_t\left[\pi_t / I_{pub}\right]$ is expected inflation rate at time t based on the public's information set at time t, y is the output gap, r the real rate of interest and d and s are demand and supply shocks, respectively.

For simplicity, we assume $\alpha = 1$, thus the Phillips curve is similar to that which could be derived by a theory of *price* stickiness (Galí and Gertler (1999); Galí (2000)). If $0 < \alpha < 1$ then the underlying model would be one in which there were *inflation* stickiness.[38] It is also important to emphasise that c is related to the degree of nominal rigidity as well as the degree of real rigidity. If prices are more flexible, the higher will be the value of c, all other things being equal.

Substituting **(A1)** into **(A2)** gives

$$\pi_t = E_t\left[\pi_t / I_{pub}\right] - cbr_t + cd_t + s_t \qquad \textbf{(A3)}$$

Information

At time t, both the public and the central bank are aware of the model's parameters. However the central bank's ability to measure the demand and supply shocks at time t is imperfect. Hence $E_t\left[s_t / I_{cb}\right] = s_t'$ and $E_t\left[d_t / I_{cb}\right] = d_t'$. The random *control* errors in demand and supply are written as $d_t - d_t'$ and $s_t - s_t'$ respectively. These errors are white noise with a known variance.

The public's knowledge of the demand and supply shocks at the time it sets its prices is subject not only to these control errors but also on white noise *transparency* errors, $E_t\left[s_t / I_{pub}\right] = s_t''$ and $E_t\left[d_t / I_{pub}\right] = d_t''$. The transparency errors in demand and supply are written as $d_t' - d_t''$ and $s_t' - s_t''$ respectively and are white noise with a known variance.

---

[38] See Batini *et al* (2000) for a model of inflation stickiness and Mankiw (2000, page 22, footnote 7) for an explanation of how the weight on backward versus forward-looking inflation is related to the coefficient on the output gap.

Both the public and the central bank are forming rational expectations; hence the control error for demand is uncorrelated both with the demand shock and the transparency error for demand. Similar assumptions hold for the supply shock. We assume that only the discretionary solution is time consistent.

The central bank minimises deviations from both the short and long-run targets and from the output gap over an infinite horizon, according to the loss function:

$$\sum_{s=0}^{\infty} L_{t+s} = 0.5 \sum_{s=0}^{\infty} E_t \left[\left(y_{t+s} \right)^2 + \lambda_1 \left(\pi_{t+s} - \pi^t_{St+s} \right)^2 + \lambda_2 \left(\pi_{t+s} - \pi_L \right)^2 \Big/ I_{cb} \right] \qquad \textbf{(A4)}$$

where π_L is the long-run inflation target, π^t_{St+s} is the short-run target at time $t+s$, and $E_t \left[z / I_{cb} \right]$ denotes expectations of z conditional on the central bank's information set.

Society's loss function is similar to the central bank's loss function but does not include deviations from the short-run target. This is because we assume that the inflation target is equal to the optimal rate of inflation, and the rate of potential output is that which the central bank targets:[39]

$$\sum_{s=0}^{\infty} L_{t+s} = 0.5 \sum_{s=0}^{\infty} E_t \left[\left(y_{t+s} \right)^2 + \lambda \left(\pi_{t+s} - \pi_L \right)^2 \Big/ I_{pub} \right] \qquad \textit{Society's loss function} \qquad \textbf{(A5)}$$

where $E_t \left[z / I_{pub} \right]$ denotes expectations of z conditional on the public's information set.

The central bank uses the nominal rate as an instrument;

$$i_t = r_t + \mathrm{E}_t \left[\pi_{t+1} / I_{pub} \right] \qquad \textit{Central bank's instrument} \qquad \textbf{(A6)}$$

With a linear model whose parameters are known, additive uncertainty and a quadratic loss function, we can solve this problem under certainty equivalence. Substituting for inflation and output, and conditioning on the central bank's information set gives the current period losses as:

$$\begin{aligned} L_t &= 0.5 \left(-br_t + d'_t \right)^2 \\ &+ 0.5 \lambda_1 \left(E_t \left[\pi_t / I_{pub} \right] - cbr_t + cd'_t + s'_t - \pi^t_{St} \right)^2 \\ &+ 0.5 \lambda_2 \left(E_t \left[\pi_t / I_{pub} \right] - cbr_t + cd'_t + s'_t - \pi_L \right)^2 . \end{aligned} \qquad \textbf{(A7)}$$

Minimising $\sum_{s=0}^{\infty} L_{t+s}$ with respect to the rate of interest gives us a first-order condition with respect to the real interest rate, taking inflation expectations as given. Substituting the expression for the rate of interest into equation **(A3)** and conditioning for the public's information set gives us a solution for inflation expectations.

---

[39] There has been much recent discussion in the literature regarding whether the relative merits of having the long-run target expressed in terms of inflation or the price level (eg Sinclair (2000), Batini and Yates (2001)). In practice, however, none of our sample of countries used a price level target.

$$E_t\left[\pi_t / I_{pub}\right] = \pi_L + \frac{\left(s_t'' - s'\right)}{c^2\lambda_2} + \frac{\left(s_t' - s_t\right)}{c^2\lambda_2} + \frac{s_t}{c^2\lambda_2} \quad \textbf{(A8)}$$

This can be used to yield solutions for the real interest rate, inflation, the output gap and the short-run inflation target as follows:

$$r_t = \frac{\left(s'' - s'\right)}{bc\left(1 + c^2\lambda_2\right)} + \frac{\left(s' - s\right)}{bc} + \frac{s}{bc} + \frac{\left(d' - d\right)}{b} + \frac{d}{b} \quad \textbf{(A9)}$$

$$\pi_t = \pi_L + \frac{\left(s_t'' - s_t'\right)}{c^2\lambda_2\left(1 + c^2\lambda_2\right)} + \frac{\left(1 - c^2\lambda_2\right)}{c^2\lambda_2}\left(s_t' - s_t\right) + \frac{s_t}{c^2\lambda_2} - c\left(d_t' - d_t\right) \quad \textbf{(A10)}$$

$$y = -\frac{\left(s_t'' - s_t'\right)}{c\left(1 + c^2\lambda_2\right)} - \frac{s_t' - s_t}{c} - \frac{s_t}{c} - \left(d_t' - d_t\right) \quad \textbf{(A11)}$$

$$\pi_{St}^t = \pi_L + \frac{\left(s_t'' - s_t'\right)}{c^2\lambda_2\left(1 + c^2\lambda_2\right)} + \frac{\left(s_t' - s_t\right)}{c^2\lambda_2} + \frac{s_t}{c^2\lambda_2} \quad \textbf{(A12)}$$

$$\pi_{St+s}^t = \pi_L \quad \text{for} \quad s = 1, \ldots, \infty. \quad \textbf{(A13)}$$

Important results are as follows:

1. Minimising $\sum_{s=0}^{\infty} L_{t+s}$ with respect to the short-run target with inflation expectations as given implies:

$$\pi_{St}^t = \pi_t^e - cbr_t + cd_t' + s_t' \quad \textbf{(A14)}$$

(A14) also follows from combining **(A8)**, **(A9)**, **(A10)** and **(A12)**. Hence the short-run target is optimal for the central bank, given the parameters λ_1 and λ_2 in the central bank's loss function.

2. Contrasting **(A8)** and **(A12)**, the short-run target only differs from the public's inflation expectations in a term in the transparency error associated with the supply-side shock.

3. Looking at the solution for inflation, **(A10)**, the elasticity of the transparency error on supply-side shocks on inflation is decreasing in c and decreasing in λ_2.

Appendix 2: Data for inflation targets and corresponding outcomes

Note: The minimum and maximum refer to the target range. For point and ceiling targets the minimum and maximum are the same.
Sources: National central banks, originally surveyed by FJMRS (2000) updated by the authors.

	Minimum	Maximum	Outcome
Albania			
1993	33.5	33.5	30.9
1994	18.9	18.9	15.8
1995	11.2	11.2	6.0
1996	13.0	13.0	17.4
1997	49.0	49.0	42.1
1998	10.0	10.0	10.0
Armenia			
1995	25.0	25.0	32.2
1996	14.3	14.3	5.7
1997	9.0	9.0	21.9
1998	9.0	9.0	-4.0
Australia			
1993	2.0	3.0	2.0
1994	2.0	3.0	2.1
1995	2.0	3.0	2.1
1996	2.0	3.0	3.2
1997	2.0	3.0	2.1
1998	2.0	3.0	1.5
1999	2.0	3.0	1.5
2000	2.0	3.0	4.5
Bangladesh			
1994	4.0	4.0	1.8
1995	4.0	4.0	5.2
1996	6.0	6.0	4.1
1997	4.0	4.0	3.9
1998	4.0	4.0	6.3
Brazil			
1999	6.0	10.0	8.9
2000	4.0	6.0	6.0
Canada			
1991	2.8	4.8	3.7
1992	2.0	4.0	2.5
1993	2.0	4.0	1.8
1994	1.5	3.5	1.8
1995	1.0	3.0	1.8
1996	1.0	3.0	1.8
1997	1.0	3.0	0.8
1998	1.0	3.0	1.0
1999	1.0	3.0	1.4
2000	1.0	3.0	1.5

	Minimum	Maximum	Outcome
Chile			
1991	15.0	20.0	18.7
1992	13.0	16.0	12.7
1993	10.0	12.0	12.2
1994	9.0	11.0	8.9
1995	9.0	9.0	8.2
1996	6.5	6.5	6.6
1997	5.5	5.5	6.0
1998	4.5	4.5	5.2
1999	4.3	4.3	3.3
2000	3.5	3.5	3.8
China			
1998	5.0	5.0	-0.8
1999	4.0	4.0	-1.0
Croatia			
1994	3.5	3.5	-3.0
1995	3.5	3.5	3.7
1996	3.5	4.0	3.4
1997	3.5	4.0	3.8
1998	3.5	4.0	5.4
1999	3.5	4.0	4.4
2000	3.5	4.0	7.4
Czech Rep.			
1998	5.5	6.5	1.7
1999	4.0	5.0	1.5
2000	3.5	5.5	3.0
2001	2.0	4.0	
Ecuador			
1994	20.0	20.0	25.4
1995	15.0	17.0	22.9
1996	17.0	19.0	24.3
1997	24.0	25.0	30.7
1998	23.0	25.0	43.4
Egypt			
1994	9.0	9.0	6.4
1995	9.4	9.4	9.9
1996	15.9	15.9	8.2
1997	9.7	9.7	4.8
1998	5.2	5.2	3.6
Finland			
1995	2.0	2.0	-0.2
1996	2.0	2.0	0.4
1997	2.0	2.0	0.8
1998	2.0	2.0	0.4

	Minimum	Maximum	Outcome
France			
1994	2.0	2.0	1.6
1995	2.0	2.0	2.1
1996	2.0	2.0	1.7
1997	2.0	2.0	1.1
1998	2.0	2.0	0.3
Georgia			
1996	22.0	22.0	13.5
1997	12.0	12.0	7.6
1998	6.0	6.0	10.1
Germany*			
1990	2.0	2.0	2.7
1991	2.0	2.0	4.2
1992	2.0	2.0	3.7
1993	2.0	2.0	3.7
1994	2.0	2.0	2.5
1995	2.0	2.0	1.8
1996	2.0	2.0	1.5
1997	2.0	2.0	1.8
1998	2.0	2.0	1.0
Greece			
1990	15.0	15.0	22.9
1991	17.0	17.0	18.0
1992	12.0	12.0	14.4
1993	10.0	10.0	12.0
1994	10.0	10.0	10.6
1995	7.0	7.0	7.9
1996	5.0	5.0	7.3
1997	4.5	4.5	4.7
Guyana			
1993	9.0	9.0	8.0
1994	8.0	8.0	16.0
1995	9.0	9.0	8.0
1996	8.0	8.0	5.0
1997	4.0	4.0	4.0
India			
1991	7.0	7.0	13.6
1992	8.0	8.0	7.0
1993	8.0	8.0	10.8
1994	7.2	7.2	10.4
1995	8.0	8.0	5.0
1996	6.0	7.0	6.9
1997	6.0	6.0	5.3
1998	5.0	6.0	4.8
1999	5.0	5.0	6.5
2000	4.5	4.5	8.5

	Minimum	Maximum	Outcome
Indonesia			
1993	5.0	5.0	10.0
1994	5.0	5.0	7.0
1995	6.7	6.7	8.6
1996	6.7	6.7	8.9
1997	6.7	6.7	5.2
1998	30.0	30.0	39.1
Israel			
1992	14.0	15.0	9.4
1993	10.0	10.0	11.2
1994	8.0	8.0	14.5
1995	8.0	11.0	8.1
1996	8.0	10.0	10.6
1997	7.0	10.0	7.0
1998	7.0	10.0	8.8
1999	4.0	4.0	1.3
2000	3.0	4.0	0.0
Italy			
1995	4.5	4.5	4.6
1996	4.0	4.0	3.9
1997	3.0	3.0	1.8
1998	2.0	2.0	1.8
Jamaica			
1996	11.0	15.0	9.5
1997	8.0	9.0	8.8
1998	6.0	8.0	9.1
Kazakhstan			
1997	17.5	17.5	11.2
1998	9.5	9.5	2.0
Korea			
1998	8.0	10.0	7.5
1999	2.0	4.0	1.4
2000	1.5	6.5	1.8
Kyrgyz Rep.			
1996	27.3	27.3	35.0
1997	17.0	17.0	14.8
1998	17.0	17.0	16.8
1999	20.0	20.0	39.9
2000	15.0	15.0	9.6
Macedonia			
1993	434.2	434.2	229.6
1994	70.0	70.0	55.4
1995	17.8	17.8	9.2
1996	6.0	6.0	0.2
1997	5.0	5.0	4.5
1998	3.0	3.0	-1.0

*The Bundesbank did not view these numbers as an inflation ‘target’.

	Minimum	Maximum	Outcome
Malaysia			
1990	4.0	4.0	3.1
1991	4.0	4.0	4.4
1992	4.0	4.0	4.7
1993	4.0	4.0	3.6
1994	4.0	4.0	3.7
1995	4.0	4.0	3.4
1996	4.0	4.0	3.5
1997	4.0	4.0	2.7
1998	4.0	4.0	5.3
Mauritius			
1996	8.0	8.0	7.9
1997	6.0	6.0	5.4
1998	6.0	6.0	5.4
1999	8.0	8.0	7.9
2000	6.0	6.0	5.3
Mexico			
1994	5.0	5.0	7.1
1995	19.0	19.0	52.0
1996	20.5	20.5	27.7
1997	15.0	15.0	15.7
1998	12.0	12.0	15.5
1999	2.0	4.0	
2000	1.5	3.5	
Moldova			
1996	15.0	15.0	15.1
1997	15.0	15.0	11.2
1998	7.0	10.0	9.6
Mongolia			
1997	35.0	35.0	17.5
1998	20.0	20.0	6.0
Mozambique			
1992	50.0	50.0	54.5
1993	30.0	30.0	43.6
1994	30.0	30.0	70.2
1995	24.0	24.0	54.9
1996	22.0	22.0	16.6
1997	14.0	14.0	5.8
1998	6.5	6.5	-1.3
New Zealand			
1990	0.0	2.0	3.4
1991	0.0	2.0	1.8
1992	0.0	2.0	1.8
1993	0.0	2.0	1.3
1994	0.0	2.0	1.5
1995	0.0	2.0	2.0
1996	0.0	2.0	2.4
1997	0.0	3.0	1.6
1998	0.0	3.0	1.1
1999	0.0	3.0	1.3
2000	0.0	3.0	4.0

	Minimum	Maximum	Outcome
Nigeria			
1993	25.0	25.0	57.2
1994	25.0	25.0	57.0
1995	15.0	15.0	72.8
1996	30.0	30.0	29.3
1997	15.0	15.0	8.5
1998	9.0	9.0	10.0
Peru			
1994	15.0	20.0	15.4
1995	9.0	11.0	10.2
1996	9.5	11.5	11.8
1997	8.0	10.0	6.5
1998	7.5	9.0	6.0
1999	5.0	6.0	3.7
2000	3.5	4.0	3.7
Poland			
1992	36.8	36.8	44.4
1993	32.2	32.2	37.6
1994	23.0	23.0	29.4
1995	17.0	17.0	21.6
1996	17.0	17.0	18.5
1997	13.0	13.0	13.2
1998	9.5	9.5	8.6
1999	6.6	7.8	9.8
2000	5.4	6.8	8.5
Portugal			
1991	12.0	12.0	18.5
1992	12.0	12.0	13.4
Romania			
1997	90.0	90.0	151.4
1998	45.0	45.0	40.6
Russia			
1995	125.0	125.0	159.0
1996	25.0	25.0	21.9
1997	12.0	12.0	11.0
1998	5.0	8.0	36.4
Sierra Leone			
1996	7.3	7.3	6.4
1997	8.0	8.0	14.9
1998	12.5	12.5	26.0
Slovakia			
1993	17.0	17.0	25.1
1994	10.0	13.2	11.7
1995	8.0	8.0	7.6
1996	6.0	7.5	5.4
1997	4.9	5.8	6.4
1998	5.6	5.9	5.6
1999	7.0	9.0	14.2
2000	8.5	9.5	8.4
2001	6.7	8.2	

	Minimum	Maximum	Outcome
Slovenia			
1997	8.8	8.8	8.8
1998	8.0	8.0	6.5
1999	?	?	8.00
2000	?	?	8.90
1990	6.3	6.3	
Spain			
1997	3.0	3.0	3.2
1998	2.5	2.5	2.0
Sweden			
1995	2.0	2.0	2.9
1996	2.0	2.0	0.7
1997	2.0	2.0	0.9
1998	2.0	2.0	0.4
1999	2.0	2.0	1.4
2000	2.0	2.0	1.4
Switzerland			
1990	3.3	3.3	5.9
1991	4.0	4.0	5.9
1992	3.5	3.5	3.5
1993	2.5	2.5	2.5
1994	2.0	2.0	0.9
1995	2.8	2.8	1.8
1996	1.5	1.5	0.8
1997	1.0	1.0	0.5
1998	1.0	1.0	0.0
1999	1.0	1.0	0.8
2000	1.0	1.0	1.6
Taiwan			
1990	3.5	3.5	4.1
1991	5.0	5.0	3.6
1992	3.5	3.5	4.5
1993	3.5	3.5	2.9
1994	3.8	3.8	4.1
1995	3.8	3.8	3.7
1996	3.6	3.6	3.1
1997	3.0	3.0	0.9
1998	3.0	3.0	1.7
Tanzania			
1990	20.0	20.0	35.9
1991	15.0	15.0	28.8
1992	10.0	10.0	21.9
1993	10.0	10.0	25.2
1994	10.0	10.0	33.1
1995	10.0	10.0	28.4
1996	10.0	10.0	21.0
1997	10.0	10.0	16.1
1998	7.5	7.5	12.8

	Minimum	Maximum	Outcome
Thailand			
2000	0.0	3.5	0.7
Turkey			
1998	58.0	58.0	54.0
Turkmenistan			
1997	18.0	20.0	21.5
1998	12.0	15.0	19.8
Uganda			
1993	15.0	15.0	-2.4
1994	15.0	15.0	16.0
1995	5.0	5.0	3.3
1996	5.0	5.0	5.4
1997	5.0	5.0	10.4
1998	5.0	5.0	-0.9
1999	5.0	5.0	5.3
2000	5.0	5.0	1.9
United Kingdom			
1993	1.0	4.0	3.0
1994	1.0	4.0	2.0
1995	2.5	2.5	2.9
1996	2.5	2.5	2.9
1997	2.5	2.5	2.8
1998	2.5	2.5	2.5
1999	2.5	2.5	2.3
2000	2.5	2.5	2.1
Uruguay			
1995	35.0	40.0	35.4
1996	25.0	30.0	24.3
1997	14.0	17.0	15.2
1998	7.0	9.0	8.3
Vietnam			
1993	10.0	10.0	5.2
1994	10.0	10.0	14.4
1995	10.0	10.0	12.7
1996	10.0	10.0	4.5
1997	8.0	8.0	3.6
1998	9.0	9.0	9.2
West African Monetary Union			
1997	5.0	5.0	3.0
1998	3.0	3.0	2.3
Zambia			
1995	35.0	35.0	45.0
1996	27.0	27.0	35.2
1997	15.0	15.0	18.6
1998	15.0	15.0	27.0

References

Aoki, K (2002), 'On the optimal monetary policy response to noisy indicators', *Journal of Monetary Economics*, forthcoming.

Arellano, M and Bond, S (1991), 'Some tests of specification for panel data: Monte Carlo evidence and an applications to employment equations', *Review of Economic Studies*, Vol. 58, pages 277-97.

Ball, L and Romer, D (1991), 'Real rigidities and the nonneutrality of money', in Mankiw, N G and Romer, D (eds), *New Keynesian economics*, Vol. 1, Imperfect competition and sticky prices, MIT Press Readings in Economics, Cambridge, Mass. and London.

Baltagi, B (1995), *Econometric analysis of panel data*, Wiley, Chichester, UK.

Barro, R and Gordon, D (1983), 'A positive theory of monetary policy in a natural rate model', *Journal of Political Economy*, Vol. 91(1), pages 589-610.

Batini, N and Haldane, A (1999), 'Forward-looking rules for monetary policy', in Taylor, J B (ed), *Monetary policy rules*, Chicago and London, University of Chicago Press.

Batini, N, Jackson, B and Nickell, S (2000), 'Inflation dynamics and the labour share in the UK', *Bank of England Monetary Policy Unit Discussion Paper No. 2*, November.

Batini, N and Yates, A (2001), 'Hybrid inflation and price level targeting', *Bank of England Working Paper no. 135*.

Bean, C (1998), 'The New UK monetary arrangements: a view from the literature', *Economic Journal*, Vol. 108, No. 451, pages 1,795-809, November.

Bernanke, B, Laubach, T, Mishkin, F and Posen, A (1999), 'Inflation targeting: lessons from the international experience', Princeton University Press, Princeton, New Jersey.

Bernanke, B and Woodford, M (1997), 'Inflation forecasts and monetary policy', *Journal of Money, Credit and Banking*, Vol. 29, pages 653-84.

Blejer, M, Ize, A, Leone, A and Werlang, S (2000), 'Inflation targeting in practice', International Monetary Fund, Washington DC.

Blinder, A (1998), 'Central banking in theory and in practice', MIT Press, Cambridge, Massachusetts,.

Blinder, A (2000), 'Central bank credibility: Why do we care? How do we build it?', *American Economic Review*, Vol. 90, No. 5, pages, 1421-31.

Boskin, M, Dulberger, E, Gordon, R, Griliches, Z and Jorgenson, D (1998), 'Consumer prices, the consumer price index, and the cost of living', *Journal of Economic Perspectives*, Vol. 12(1), pages 3-26, Winter.

Bufman, D and Leiderman, L (2000), 'Monetary policy and disinflation in Israel', in Mahadeva, L and Sterne, G (eds), *Monetary frameworks in a global context*, Routledge, London.

Cecchetti, S (2001), 'Making monetary policy: objectives and rules', *Oxford Review of Economic Policy*, Vol. 16, No.4, pages 1-31.

Chortareas, G, Stasavage, D and Sterne, G (2001), 'Does it pay to be transparent? International evidence from central bank forecasts', *Bank of England Working Paper no. 143*, and forthcoming in *Reserve Bank of St Louis Review*.

Clarida, R, Galí, J and Gertler, M (1999), 'The science of monetary policy: a new Keynesian perspective', *Journal of Economic Literature*, Vol. 37(4), pages 1,661-707, *National Bureau of Economic Research Working Paper*, No. 7147.

Clarida, R, Galí, J and Gertler, M (2001), 'Optimal monetary policy in closed versus open economies: an integrated approach', *National Bureau of Economic Research Working Paper*, No 8604.

Corbo, V, Landerretche Moreno, O and Schmidt-Hebbel, K (2002), 'Does inflation targeting make a difference?', in Loayza, N and Soto, R (eds), *Ten years of inflation targeting: design, performance, challenges*, Central Bank of Chile Santiago, Chile.

Cufer, U, Mahadeva, L and Sterne, G (2000), 'Specifying an inflation target: the case of administered prices and other candidates for exclusion', in Mahadeva, L and Sterne, G (eds), *Monetary policy frameworks in a global context*, Routledge, London.

Cukierman, A (1992), 'Central bank strategy, credibility, and independence: theory and evidence', MIT Press, Cambridge, Massachusetts.

Cukierman, A (2000), 'Accountability, credibility, transparency and stabilization policy in the eurosystem', Tel-Aviv University.

Cukierman, A and Meltzer, A (1986), 'A theory of ambiguity, credibility, and inflation under discretion and asymmetric information', *Econometrica*, Vol. 54(5), pages 1,099-128, September.

Eichengreen, B (2001), 'Can emerging markets float? Should they inflation target?', paper presented at the Bank of England's Centre for Central Banking Studies Research Workshop on Inflation, March 2001.

Eijffinger, S, Hoeberichts, M and Schaling, E (2000), 'Why money talks and wealth whispers: monetary uncertainty and mystique', *Journal of Money, Credit and Banking*, Vol. 32, No. 2, May, pages 218-35.

Faust, J and Svensson, L (1998), 'Transparency and credibility: monetary policy with unobservable goals', *National Bureau of Economic Research Working Paper*, No. 6452.

Faust, J and Svensson, L (1999), 'The equilibrium degree of transparency and control in monetary policy', *Board of Governors of the Federal Reserve System: International Finance Discussion Paper*, Vol. 24, November.

Fry, M, Julius, D, Mahadeva, L, Roger, S and Sterne, G (2000), 'Key issues in the choice of monetary policy framework', in Mahadeva, L and Sterne, G (eds), *Monetary frameworks in a global context*, Routledge, London.

Galí, J (2000), 'The return of the Phillips curve and other recent developments in business cycle theory', *Spanish Economic Review*, Vol. 2(1), pages 1-10, April.

Galí, J and Gertler, M (1999), 'Inflation dynamics: a structural econometric analysis', *Journal of Monetary Economics*, Vol. 44(2), pages 195-222, October.

Geraats, P (2001), 'Why adopt transparency? The publication of central bank forecasts', *European Central Bank Working Paper Series No. 41*.

Geraats, P (2002), 'Monetary policy transparency', *mimeo*, University of Cambridge.

Haldane, A (ed) (1995), *Targeting inflation*, Bank of England, London.

Hall, S, Salmon, C, Yates, A and Batini, N (1999), 'Uncertainty and simple monetary policy rules: an illustration for the United Kingdom', *Bank of England Working Paper no. 96*.

Hrnčíř, M and Šmidkova, K (2000), 'Inflation targeting in the Czech Republic', in Mahadeva, L and Sterne, G (eds), *Monetary frameworks in a global context*, Routledge, London.

Jensen, H (2000), 'Optimal degrees of transparency in monetary policy-making', *Working Paper*, University of Copenhagen.

King, M (1996), 'How should central banks reduce inflation - conceptual issues', *Bank of England Quarterly Bulletin*, Vol. 36, No. 4, pages 434-48.

Landerretche, O, Morande, P and Schmidt-Hebbel, K (2000), 'Inflation targets and stabilisation in Chile (1991–98)', in Mahadeva, L and Sterne, G (eds), *Monetary frameworks in a global context*, Routledge, London.

Leiderman, L and Svensson, L (eds) (1995), *Inflation targets*, CEPR, London.

Loayza, L and Soto, R (eds) (2002), *Ten years of inflation targeting: design, performance, challenges*, Central Bank of Chile Santiago, Chile.

Lohmann, S (1992), 'Optimal commitment in monetary policy', *American Economic Review*, Vol. 82, pages 237–86.

Mahadeva, L and Sinclair, P (eds) (2001), 'The theory and practice of monetary transmission in diverse economies', Cambridge University Press, forthcoming.

Mahadeva, L and Šmidkova, K (2000), 'Modelling the transmission mechanism of monetary policy in the Czech Republic', in Mahadeva, L and Sterne, G (eds), *Monetary frameworks in a global context*, Routledge, London.

Mahadeva, L and Sterne, G (eds) (2000), *Monetary frameworks in a global context*, Routledge, London.

Mankiw, N (2000), 'The inexorable and mysterious trade-off between inflation and unemployment', Harvard University, August.

Masson, P, Savastano, M A and Sharma, S (1997), 'The scope for inflation targeting in developing economies', *IMF Working Paper No. 130*.

Mishkin, F and Schmidt-Hebbel, K (2002), 'One decade of inflation targeting in the world: what do we know and what do we need to know?', in Loayza, N and Soto, R (eds), *Ten years of inflation targeting: design, performance, challenges*, Central Bank of Chile Santiago, Chile. 2002.

Morris, S and Shin, H (2001) 'Rethinking multiple equilibria in macroeconomic modelling' *NBER Macroeconomics Annual 2000*, pages 139-61, MIT Press, 2001.

Pesaran, M and Smith, R (1995), 'Estimating long-run relationships from dynamic hetereogeneous panels', *Journal of Econometrics*, No. 68, pages 79-113.

Rogoff, K (1985), 'The optimal degree of commitment to an intermediate monetary target', *Quarterly Journal of Economics*, Vol 1 November, pages 169–90.

Sack, B (1998), 'Uncertainty, learning, and gradual monetary policy', *Board of Governors of the Federal Reserve System: Finance and Economics Discussion Paper Series 98/34*.

Sargent, T (1999), *The conquest of American inflation*, Princeton University Press, Princeton.

Schaechter, A, Stone, M and Zelmer, M (2000), 'Adopting inflation targeting: practical issues for emerging market countries', *IMF Occasional Paper No. 202*.

Sinclair, P (2000), 'Inflation: policy choices and U.K. experience', in '*Practical Experiences on Inflation Targeting: Proceedings of an International Economic Conference*', Bank of Thailand, Bangkok, Thailand.

Srour, G (1999), 'Inflation targeting under uncertainty', *Bank of Canada Technical Report*, No. 85.

Sterne, G (2002), 'Inflation targets in a global context', in Loayza, N and Soto, R (eds), *Ten years of inflation targeting: design, performance, challenges*, Central Bank of Chile Santiago, Chile.

Svensson, L (1999), 'Inflation targeting as a monetary policy rule', *Journal of Monetary Economics*, No 43, pages 607-54.

Svensson, L (2001), 'Price stability as a target for monetary policy: defining and maintaining price stability', in *The monetary transmission process: recent developments and lessons for Europe*, Deutsche Bundesbank, London, Macmillan.

Walsh, C (1995), 'Optimal contracts for central bankers', *American Economic Review*, Vol. 85, pages 150-67.

Walsh, C (1998), *Monetary theory and policy*, MIT Press.

Walsh, C (1999), 'Announcements, inflation targeting and central bank incentives', *Economica*, Vol. 66, pages 255-69.