Does Inflation Targeting Make a Difference?

Vittorio Corbo
Pontificia Universidad Católica de Chile

Óscar Landerretche
Massachusetts Institute of Technology

Klaus Schmidt-Hebbel
Central Bank of Chile

Inflation targeting is the new kid on the block of monetary regimes. Since New Zealand and Chile first adopted the regime in 1990, a growing number of industrial and developing countries have followed suit, anchoring their monetary policy to explicit targets for inflation. Even the Deputy Chairman of the Federal Reserve System recently suggested introducing inflation targeting in the United States (Meyer, 2001).

Does the adoption of inflation targeting make a difference? While inflation-targeting countries have reduced their inflation levels, careful evidence provides a more cautious picture. Bernanke and others (1999) show that the adoption of inflation targeting did not make a difference with regard to the cost and speed of price stabilization. Cecchetti and Ehrmann (2002) report that inflation-targeting countries exhibit degrees of inflation aversion that are not higher, on average, than those of nontargeters. Mishkin and Schmidt-Hebbel (in this volume) provide evidence that countries under inflation targeting exhibit some structural differences in comparison with countries under alternative monetary frameworks.

A large number of questions on the results of inflation targeting remain open. How successful have countries been in reducing infla-

We thank Ben Bernanke, Bennett McCallum, Dale Henderson, Eduard Hochreiter, Zbigniew Polanski, Mark Taylor, Alejandro Werner, and Volker Wieland for excellent comments and discussions. We are grateful to Verónica Mies and José Tessada for outstanding research assistance.

Inflation Targeting: Design, Performance, Challenges, edited by Norman Loayza and Raimundo Soto, Santiago, Chile.

tion? How costly has disinflation been under inflation targeting? Does inflation targeting improve the ability to predict inflation? Does the behavior of the macroeconomy change under inflation targeting? Does inflation targeting change central bank aversion to inflation? Does inflation targeting change central bank behavior? What is the transmission mechanism of inflation targeting? This paper addresses these questions by conducting a wide empirical analysis of the features and effects of inflation targeting, by comparing the performance of countries with and without inflation targets, and by carrying out a case study of Chile, the emerging market economy with the most extensive experience.

Section 1 introduces the sample of inflation targeters used in this paper and compares their performance with that of other groups of countries, focusing on their success in meeting inflation targets, sacrifice ratios, and output volatility. Section 2 investigates whether inflation targeting improves the ability to predict inflation by studying differences in vector autoregression (VAR) structures between targeters and nontargeters. Section 3 studies whether the behavior of the macroeconomy changes under inflation targeting. Section 4 draws on the methodology of Cecchetti and Ehrmann (2002) to analyze whether central banks' degree of aversion toward inflation is different among targeters and nontargeters. Section 5 examines whether inflation targeting changes central bank behavior. Section 6 outlines the experience of Chile, the emerging market economy that introduced inflation targeting in 1990. Section 7 summarizes the main conclusions.

1. Differences among Inflation Targeters and Nontargeters

Much recent work describes the design features and general results of inflation targeting in the small but quickly growing number of countries that have adopted inflation targeting since 1990.[1] In this section we complement this literature by describing the sample of inflation targeters and comparing their performance with that of other country groups. We focus, in particular, on their inflation performance and success in meeting their targets, as well as on their output sacrifice and output volatility.

1. See, in particular, Leiderman and Svensson (1995); Mishkin and Posen (1997); Bernanke and others (1999); Kuttner and Posen (1999); Haldane (1999); Mishkin (2000); Mishkin and Savastano (2000); Schaechter, Stone, and Zelmer (2000); Agénor (in this volume); Mishkin and Schmidt-Hebbel (in this volume).

1.1 Who Targets Inflation?

Inflation targeting is based on the central bank's commitment to attaining a publicly announced quantitative inflation target over the relevant policy horizon. Its two crucial prerequisites are absence of fiscal dominance and absence of conflict with other nominal policy objectives. Central bank independence, policy transparency, and central bank accountability to political bodies and society at large strengthen the exercise of constrained discretion under inflation targeting (Bernanke and others, 1999).

While the literature exhibits a broad consensus on this general definition of inflation targeting, it is still controversial to apply this definition to identify an empirically relevant sample of inflation targeting experiences. The reason for disagreement on sample selection and the start dates for inflation-targeting regimes is that the adoption of inflation targeting has been more evolutionary than revolutionary. Most countries have adopted this new monetary framework gradually, learning over time and from other countries what exactly defines a full-fledged inflation targeting framework.

According to Schaechter, Stone, and Zelmer (2000), thirteen countries had implemented full-fledged inflation-targeting regimes as of February 2000: Australia, Brazil, Canada, Chile, the Czech Republic, Finland, Israel, New Zealand, Poland, South Africa, Spain, Sweden, and the United Kingdom. Of these, Finland and Spain abandoned inflation targeting in January 1999 when they joined the European Monetary Union (EMU). We follow Schaechter, Stone, and Zelmer in classifying countries, though not always in dating the start of inflation-targeting experiences. We also add two recent newcomers to their thirteen countries, namely, Korea and Thailand, thus including fifteen full-fledged inflation-targeting countries through August 2000.

For our empirical analysis of the 1980–99 period, we introduce three country groups. Group 1 comprises nine countries that had inflation targeting in place by 1995 (called inflation targeters). This group is divided into two subsamples: two emerging countries that are transition inflation targeters, in the sense that they started inflation targeting at inflation levels substantially above stationary levels (Chile and Israel) and seven industrial countries that are stationary inflation targeters, in the sense that they started inflation targeting at inflation levels close to stationary levels (Australia, Canada, Finland, New Zealand, Spain, Sweden, and the United Kingdom).

Group 2 includes four emerging economies that were on their way to inflation targeting in the 1990s, that is, countries that recently adopted inflation targeting or that currently have a partial inflation-targeting framework in place. These are Colombia, Korea, Mexico, and South Africa. We call these countries potential inflation targeters in view of their transition toward inflation targeting in the 1990s.[2]

Group 3 is a set of control countries encompassing ten industrial economies that are not inflation targeters: Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Switzerland, and the United States. These countries have no explicit inflation targets in place; in the case of EMU members, they adopted the euro after targeting their exchange rates to the deutsche mark for most of the 1990s.[3] We label this control group nontargeters.

Figure 1 depicts the adoption dates and inflation rates at adoption for twenty-one countries that had inflation-targeting experiences as of August 2001: our thirteen sample countries, four countries that were omitted from our sample (Brazil, the Czech Republic, Peru, and Poland), and four countries that adopted inflation targeting very recently (Iceland, Norway, Switzerland, and Thailand).[4] The following facts are apparent from inspection of figure 1.

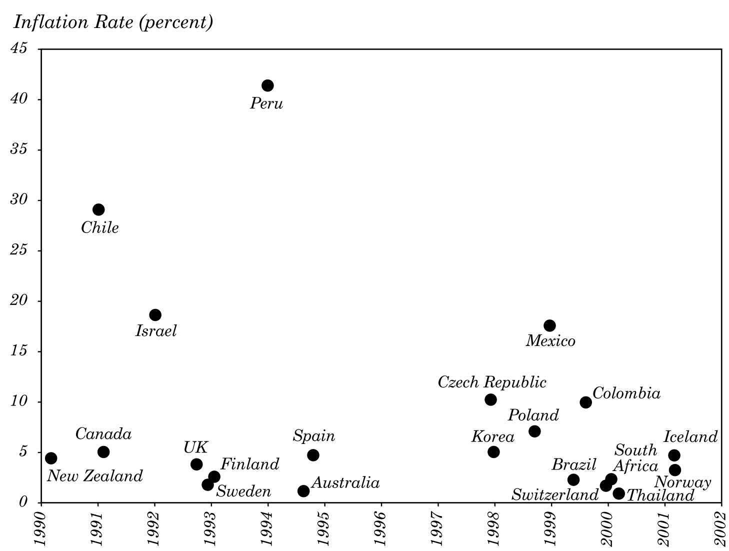
Among the nineteen countries that had inflation targeting in place as of August 2001, eight are industrial countries and eleven are emerging economies. About four countries per year have adopted inflation targeting since 1998. A salient feature of the international inflation-targeting experience is that many emerging countries adopted inflation targeting when they were still at inflation levels well above stationary inflation rates. In Chile and Israel, inflation stood at 29 percent and 19 percent, respectively, when inflation targeting was adopted in the early 1990s. In more recent cases of inflation-targeting adoption, Colombia and Mexico had initial inflation rates of 10 percent and 18

2. Because of data problems, we omitted from this group three full-fledged inflation targeters that were, for example, included in the samples of inflation-targeting countries in Schaechter, Stone, and Zelmer (2000) and Mishkin and Schmidt-Hebbel (in this volume). Brazil was not included because of its hyperinflation experience in the 1980s and early 1990s, while the Czech Republic and Poland were omitted owing to lack of information for the 1980s.

3. Because our empirical analysis is carried out through 1999, the control group of nontargeters includes Switzerland, which adopted inflation targeting in December 2000, and Norway, which adopted inflation targeting in March 2001.

4. Start dates are defined by the first month of the first period for which inflation targets were previously announced. For example, the start date for Chile is January 1991, that is, the first month of calendar year 1991, for which the first inflation target was announced in September 1990. The initial inflation level is defined as the year-on-year consumer price index inflation rate of the last quarter before the first month of inflation targeting (1990:4 in the case of Chile).

Figure 1. Inflation at Adoption of Inflation-Targeting Framework in Twenty-One Countries, 1990–2001[a]



Source: Authors' calculations, based on data from IFS, country sources, and Schaechter, Stone, and Zelmer (2000).
a. Inflation attained one quarter before the adoption of inflation targeting.

percent, respectively, Korea had initial inflation close to 5 percent, and Brazil and South Africa had initial inflation close to 3 percent.[5] The subsequent success of emerging countries in bringing inflation toward low stationary levels is prima facie evidence that inflation targeting can be successfully employed to reduce inflation from low double-digit levels toward low single-digit rates, as discussed in the next section.

1.2 Countries' Success under Inflation Targeting

We measure the success of inflation targeting in three simple dimensions: the reduction of inflation shortly before and after adopting inflation targeting, the speed at which inflation was brought down from the start of inflation targeting through the attainment of stationary inflation, and the average deviation of inflation outcomes from target levels.

5. Inflation attained one quarter before the adoption of inflation targeting.

Table 1. Alternative Measures of Initial Disinflation in Inflation-Targeting Countries

Country	*(t – 1 to t + 1)*	*(t – 2 to t + 1)*	*(t – 3 to t + 1)*
Australia	0.9	–1.3	–5.4
Canada	–3.3	–3.5	–2.5
Colombia[a]	–17.5	–16.0	–17.3
Chile	–10.6	–1.6	0.8
Finland	–1.5	–3.0	–5.0
Israel	–8.1	–6.2	–9.3
Korea	–3.6	–4.1	–3.7
Mexico[a]	–8.7	–13.4	–27.2
New Zealand	–5.8	–4.7	–14.1
Spain	–1.2	–1.0	–2.4
Sweden	–0.1	–7.1	–8.3
South Africa[a]	–1.4	–3.1	–4.8
United Kingdom	–1.3	–3.9	–7.0
Average	**–4.8**	**–5.3**	**–8.2**

Source: Authors' calculations, based on data from International Financial Statistics (IFS) and J.P. Morgan.
a. Based on projected inflation.

Table 2. Convergence to Stationary Inflation under Inflation Targeting, 1989–2000[a]

Country	*Initial inflation*	*Date*	*Final inflation*	*Date*	*Quarters of convergence*	*Inflation change*	*Average inflation per quarter*
Inflation targeters							
Australia	1.2	1993:1	1.2	1993:1	0	0.0	—
Canada	4.9	1990:4	1.6	1992:1	5	–3.3	–0.7
Chile	29.0	1990:4	2.5	1999:4	36	–26.5	–0.7
Finland	2.5	1992:4	2.0	1993:3	3	–0.5	–0.2
Israel	18.5	1991:4	1.9	1999:4	24	–16.7	–0.7
New Zealand	4.4	1989:2	2.8	1991:2	8	–1.6	–0.2
Spain	4.7	1994:3	1.6	1997:2	11	–3.1	–0.3
Sweden	1.8	1992:4	1.8	1992:4	0	0.0	—
United Kingdom	3.6	1992:3	1.8	1993:1	2	–1.8	–0.9
Average	**7.8**		**1.9**		**9.9**	**–5.9**	**–0.5**
Potential inflation targeters							
Colombia	10.0	1999:2	10.6	2000:2	4	0.6	0.2
Korea	5.1	1997:4	0.7	1999:1	5	–2.4	–0.5
Mexico	17.6	1998:4	10.6	2000:1	5	–7.0	–1.4
South Africa	2.0	1999:4	2.0	1999:4	0	0.0	—
Average	**8.7**		**6.0**		**3.5**	**–2.2**	**–0.6**
Overall average	**8.1**		**3.2**		**7.9**	**–4.8**	**–0.5**

Source: Authors' calculations, based on data from IFS, country sources, and Schaechter, Stone, and Zelmer (2000).
a. Convergence refers to most recent available observation. Stationary inflation for countries that do not explicitly announce a long-term inflation target is defined as inflation attained by industrial countries (2–3 percent).

A general feature of inflation targeting is that countries prepare for its adoption by reducing inflation around the implementation date (noted as year *t* in table 1). This feature is generally observed throughout the sample, including among inflation targeters and potential inflation targeters, industrial and emerging economies, and transition and stationary targeters. Depending on the selected period, thirteen inflation targeters reduced inflation rates by measures ranging, on average, from 5.3 percent (between years $t - 2$ and $t + 1$) to 8.2 percent (between years $t - 3$ and $t + 1$). Our sample of inflation targeters reduced inflation by 5.9 percent, on average, in the period from three years before to one year after the adoption date and by 3.4 percent from one year before to one year after the adoption date. Similar results are observed in the sample of potential inflation targeters, which reduced inflation, on average, by 13.3 percent and 7.8 percent during the two periods.

Table 2 displays the speed of convergence to stationary inflation among inflation targeters and potential inflation targeters. The nine inflation targeters reached stationary inflation levels in ten quarters, on average. Chile and Israel had the longest transition periods (thirty-six and twenty-four quarters, respectively), which is not surprising considering their high initial inflation rates. Australia and Sweden represent the other extreme, as they adopted inflation targeting when they had already attained stationary inflation.

Inflation targeters have been successful in meeting their targets (see table 3). As measured by the average relative deviation of actual annual inflation from target inflation, the nine inflation-targeting countries missed only 12 basis points, on average, a figure that rises to 66 basis points when considering the average absolute deviation. Canada, the United Kingdom, and Chile were closest to target, while Israel, Sweden, and Finland scored the highest deviations. Similar results are obtained when scaling relative and absolute deviations to annual inflation rates, which is a necessary correction to account for large country differences in inflation levels during transition to stationary inflation. Using this alternative measurement, Israel and Spain join Chile and the United Kingdom as the countries that were most on target, while Finland, Australia, and Sweden show the largest deviations.

1.3 The Cost of Disinflation under Inflation Targeting

A straightforward measure of the costs of disinflation under inflation targeting is the sacrifice ratio—that is, the percentage output loss

Table 3. Annual Average Deviation of Actual from Target Inflation under Inflation Targeting, 1989–2000[a]

	Percentage points		*As a ratio to current inflation*	
Country	*Relative*	*Absolute*	*Relative*	*Absolute*
Inflation targeters				
Australia	–0.18	1.13	1.25	1.44
Canada	–0.15	0.20	–0.60	0.67
Chile	–0.12	0.40	–0.08	0.12
Finland	–0.69	0.69	–2.12	2.12
Israel	0.46	1.62	0.02	0.14
New Zealand	0.06	0.40	–0.08	0.25
Spain	0.15	0.45	–0.01	0.21
Sweden	–0.71	0.71	1.05	1.05
United Kingdom	0.09	0.31	0.00	0.12
Average	**–0.12**	**0.66**	**–0.06**	**0.68**
Potential inflation targeters				
Colombia	–5.23	5.23	–0.54	0.54
Korea	–2.30	2.30	–0.71	0.71
Mexico	–0.68	0.68	–0.06	0.06
South Africa	n.a.	n.a.	n.a.	n.a.
Average	**–2.74**	**2.74**	**–0.44**	**0.44**
Overall Average	**–0.78**	**1.18**	**–0.16**	**0.62**

Source: Authors' calculations, based on data from IFS, country sources, and Schaechter, Stone, and Zelmer (2000).
a. Subperiods vary by country. Relative (absolute) deviation: sum of relative (absolute) deviations divided by number of periods. Relative (absolute) deviation as a ratio to current inflation: sum of relative (absolute) deviations as ratios to inflation divided by number of periods. The inflation target is defined as either a range or a point, depending on the inflation-targeting framework.

per percentage unit of inflation reduction. Table 4 computes sacrifice ratios for gross domestic product (GDP) and industrial production and for inflation targeters and potential inflation targeters, using the period ranging from three years before to one year after the adoption of inflation targeting (as represented in table 1).[6] Among the nine inflation targeters, the sacrifice ratio averaged 0.60 (based on GDP), 6.6 (based on industrial output), and 3.1 (based on industrial output but excluding Chile and Spain, two large outliers). Among five potential inflation targeters, the sacrifice ratio averaged –0.4 when using GDP and –0.2 when using industrial production. Country dispersion is moderate when using GDP and high when using industrial production, ranging from –2.3 to 2.5 and from –4.2 to 23.3, respectively.

6. Sacrifice ratios were computed as ratios of the sum of deviations of potential from actual output divided by the reduction in consumer price index inflation. They were based on annual frequency for GDP-based measures and quarterly data for industrial-output-based measures. Average sacrifice ratios based on industrial output are calculated with and without two large outliers (Chile and Spain).

Table 4. Sacrifice Ratios during Inflation Stabilization with Inflation Targeting, 1980–2000[a]

Inflation targeters			*Potential inflation targeters*		
Country	*GDP*	*Industrial production*	*Country*	*GDP*	*Industrial production*
Australia	1.1	3.3	Colombia	0.2	1.8
Canada	–2.3	–4.2	Korea	0.4	1.7
Chile	–0.4	23.3	Mexico	–0.0	–2.7
Finland	2.4	6.2	South Africa	–2.3	–1.5
Israel	0.6	4.6			
New Zealand	0.2	–2.1			
Spain	2.5	18.2			
Sweden	0.6	6.6			
United Kingdom	0.9	3.8			
Average	**0.6**	**6.6**	**Average**	**–0.4**	**–0.2**

Source: Authors' calculations, based on data from IFS and country sources.

a. Based on annual GDP and quarterly industrial production data; subperiods vary by country. Sacrifice ratios calculated as cumulative GDP (industrial production) variation (to a trend calculated by a Hodrick-Prescott filter) divided by inflation change between three years before and one year after the year in which inflation targeting was adopted.

Table 5. GDP-Based Sacrifice Ratios during Inflation Stabilization, 1980–2000[a]

Inflation targeters			*Potential inflation targeters*		*Nontargeters*	
Country	*Before*	*After*	*Country*	*1990s*	*Country*	*1990s*
Australia	–1.41	0.01	Colombia	0.00	Denmark	0.90
Canada	–6.84	0.64	Korea	0.15	France	–0.45
Chile	0.37	–0.7	Mexico	–3.06	Germany	–0.12
Finland	0.03	–4.74	South Africa	–5.69	Italy	0.25
Israel	0.17	–0.14			Japan	1.46
New Zealand	–0.67	0.22			Netherlands	1.47
Spain	–0.85	0.82			Norway	–0.87
Sweden	0.08	0.22			Portugal	–0.39
United Kingdom	0.75	0.02			Switzerland	0.87
					United States	0.78
Average[b]	**–0.22**	**0.06**	**Average**	**–2.15**	**Average**	**0.39**

Source: Authors' calculations, based on data from IFS and country sources.

a. Based on annual GDP data; subperiods vary by country among inflation targeters. Sacrifice ratios are calculated as the cumulative GDP variation (to a trend calculated by a Hodrick-Prescott filter) divided by inflation change in any disinflation period. Inflation targeters' sacrifice ratios are calculated before and after the adoption of the inflation-targeting framework, with the former period measured from 1980 to the year of adoption. Outlier observations are excluded.

b. Excluding Canada and Finland.

Table 6. Industrial Production Sacrifice Ratios during Inflation Stabilization, 1986–2000[a]

Inflation targeters			*Potential inflation targeters*		*Nontargeters*	
Country	*Before*	*After*	*Country*	*1990s*	*Country*	*1990s*
Australia	–1.3	0.1	Colombia	–0.1	Denmark	–0.8
Canada	–1.2	1.4	Korea	–0.4	France	–1.2
Chile	–0.5	–0.6	Mexico	–0.6	Germany	3.0
Finland	3.2	–4.5	South Africa	–2.9	Indonesia	–3.3
Israel	3.5	0.0			Italy	3.7
New Zealand	–0.2	–0.2			Japan	2.8
Spain	1.8	–4.9			Netherlands	3.7
Sweden	0.0	–2.2			Norway	–0.7
United Kingdom	–0.8	0.3			Portugal	–0.1
					Switzerland	2.0
					United States	–0.7
Average	**0.5**	**–1.2**	**Average**	**–1.0**	**Average**	**1.2**

Source: Authors' calculations, based on data from IFS and country sources.
a. Based on quarterly industrial production data; subperiods vary by country. Sacrifice ratios are calculated as the cumulative Industrial Production variation (to a trend calculated by a Hodrick-Prescott filter) divided by inflation change in any disinflation period. Inflation targeters' sacrifice ratios are calculated before and after the adoption of the inflation-targeting framework, with the former period measured from 1980 to the year of adoption. Outlier observations are excluded.

An alternative method is to compare sacrifice ratios for disinflation periods under inflation targeting with sacrifice ratios before adopting inflation targeting in the same country group and with comparable sacrifice ratios among potential inflation targeters and nontargeters (tables 5 and 6). Despite large country variation, the set of nine inflation targeters does not demonstrate a clear difference in GDP-based sacrifice ratios before and after the adoption of inflation targeting. Excluding outliers, average sacrifice ratios before and after adoption are –0.2 and 0.1, respectively. These figures are lower than the average sacrifice ratio of 0.5 recorded by nontargeters during disinflation periods in the 1990s and substantially larger than the average figure of –2.2 observed among potential inflation targeters (table 5).

A different result emerges, however, when using industrial production. On average, sacrifice ratios after the adoption of inflation targeting were highly negative (–1.2) among inflation targeters and hence much lower than those recorded by the same country group before the adoption of inflation targeting (0.5). They were also lower than the average sacrifice ratios observed among nontargeters (1.2) and potential inflation targeters (–1.0). This result represents preliminary evidence suggesting that inflation targeting contributed to lowering output costs

Table 7. Output Volatility, 1980–2000[a]

Inflation targeters			*Potential inflation targeters*			*Nontargeters*	
Country	*Before*	*After*	*Country*	*Before*	*After*	*Country*	*1990s*
Australia	2.8	1.2	Colombia	4.5	—	Denmark	2.8
Canada	4.4	2.2	Korea	3.6	9.4	France	1.6
Chile	6.2	3.1	Mexico	4.0	—	Germany	2.4
Finland	3.1	2.5	South Africa	3.2	—	Italy	2.3
Israel	2.9	1.7				Japan	3.3
New Zealand	3.4	3.1				Netherlands	2.2
Spain	2.4	1.7				Norway	2.8
Sweden	3.1	3.4				Portugal	10.8
United Kingdom	2.4	1.3				Switzerland	2.8
						United States	2.3
Average	**3.4**	**2.2**	**Average**	**3.8**	**9.4**	**Average**	**3.3**

Source: Authors' calculations, based on data from IFS and country sources.
a. Based on quarterly industrial production data; subperiods vary by country. Volatility is calculated as standard deviation of industrial production variation (to a trend calculated by a Hodrick-Prescott filter).

of inflation stabilization, at least when considering higher-frequency measures of industrial output (table 6).

A related result is obtained with output volatility. We compare the volatility of industrial output before and after the adoption of inflation targeting in nine inflation targeters and only one potential inflation targeter (see table 7). Output volatility fell in eight of the nine countries, and in six of them the reduction in the standard deviation of industrial output was significant at least at the 10 percent level. Output volatility among inflation targeters is similar to that observed among nontargeters during the 1990s.

2. Inflation Targeting and the Ability to Predict Inflation

In countries that have introduced inflation targeting to converge to steady-state levels of inflation, inflation targets carry information on the monetary stance of the central bank. The announcement of the inflation target should be news for the market, and inflation expectations should be affected by the target set by the bank. The target signals how aggressive disinflation will be during the relevant period, acting as a coordination mechanism and a commitment device. As a coordination mechanism, central bank announcement of the inflation target could contribute to lowering the inflation forecast error since agents benefit from lower uncertainty regarding the parameters of the economy in which they are operating. The target carries less information in countries that are close at steady-state inflation than in those that are converging to steady-state levels. However, the credible commitment of the monetary authority to a numerical target may also contribute to better coordination among agents and markets. For example, announcing inflation targets may reduce agents' reaction to inflation news or the dependence of specific prices on formal or informal indexation mechanisms, thereby aligning expectations closer to central bank actions.

In this section, we estimate country VAR models, show differences in VAR structures between inflation targeters and nontargeters, and report how one-step-ahead inflation forecast errors (constructed from the country VARs) have evolved over time in the three country groups. We have put together a database of quarterly data for the period 1980–99 for five relevant macroeconomic variables: industrial production (IP)[7], money (M), consumer prices (CPI), interest rates (IR), and the nominal exchange rate (NER). To avoid estimating different cointegration structures for different countries, we specify all variables (except the interest rate) as deviations from a potentially nonstationary trend measured by the standard Hodrick-Prescott filter.[8]

We assume that the structure of the economy can be adequately described by a nonstructural vector autoregressive simultaneous equation system. We run a comprehensive model, common to all economies, described by the stationary components of their major macroeconomic variables. The unrestricted VAR is based on five endogenous variables ordered from more to less endogenous: CPI, IP, M, NER, IR.[9] We also include two exogenous variables: international interest rates and oil prices. The inflation equation of the VAR is used to generate a one-period-ahead out-of-sample forecast of inflation, which is our proxy of inflation expectations. To make robust inferences, we estimate two types of VARs, namely, a seven-year moving window and a recursive estimation based on additional sample information.

7. We use industrial production to construct a measure of the output gap because of the availability of quarterly data for some of our emerging market economies.

8. The filter is estimated with a 1600 penalty parameter on the second derivative of the trend. Each variable is measured as the logarithmic deviation from trend, which allows us to focus on the relationships among the stationary components of the set of macroeconomic variables. In the case of industrial production, the resulting series is an approximation of the gap between actual and potential output; in the case of inflation the resulting series is a deviation from trend inflation.

9. In other words, the short-term interest rate is the most exogenous variable. We assume this rate is closely aligned with the policy interest rate of the central bank.

As discussed above, we take central banks' declared inflation-targeting start dates at face value. Although true inflation-targeting regime requires high credibility that is only built up over time, we do not attempt to measure credibility in this paper. However, all the statistics that we generate are dynamic in that they are generated from rolling or recursive VARs, which allows economic structures to change over time as we add more periods under an inflation targeting regime.[10]

Our VAR results are used for generating inflation deviation forecasts for each country, based on the rolling or recursive estimations.[11] We use four lags in the estimations, which come from the rolling and recursive estimations using the Akaike, Schwartz, and Hannan-Quinn information criteria for each country.[12]

To assess the effect of the inflation-targeting regime on the formation of inflation expectations, we generate the square of the forecast errors from the VARs and average them across inflation targeters and nontargeters. To control for the fact that high inflation forecast errors could be related to high inflation levels, we divide by the trend level of inflation that we have estimated before aggregating by country.[13]

Figures 2 and 3 depict average quadratic inflation forecast errors for different samples of inflation targeters and nontargeters. In panels I, III

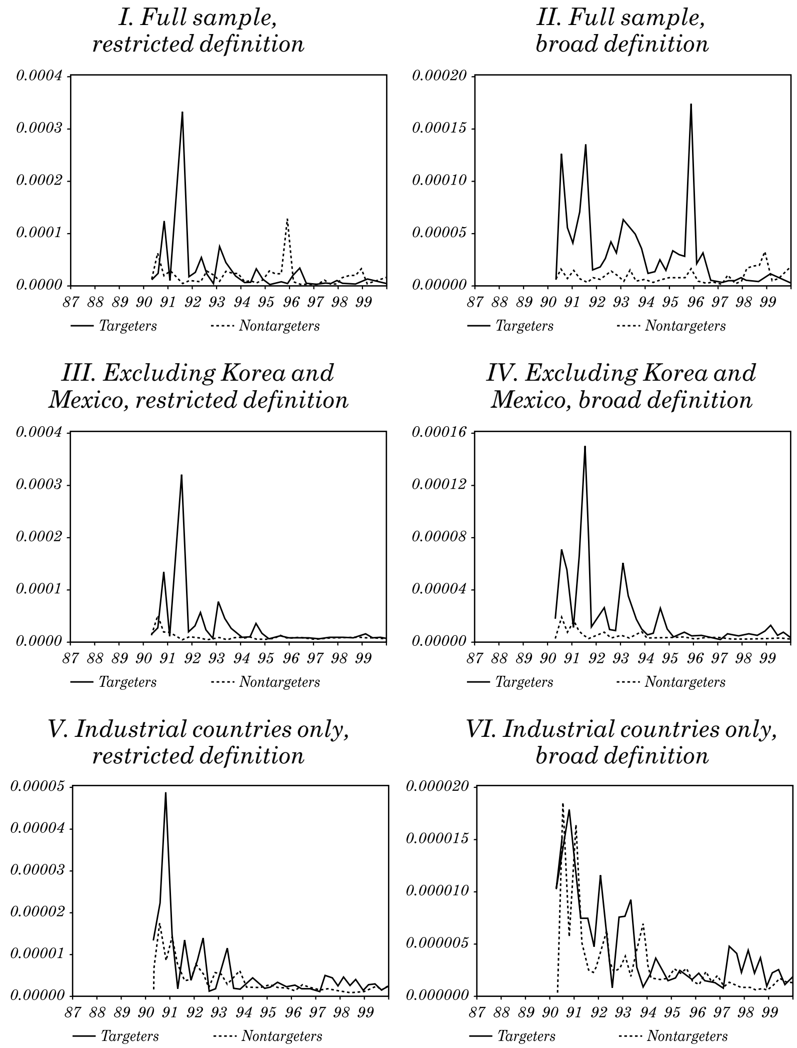
10. It would be conceivable to conduct robustness tests for alternative inflation targeting starting dates or to test whether the results hold when countries shift from potential inflation targeting to inflation targeting categories at different dates. This would be equivalent to testing for the date at which the countries became full-fledged inflation targeters, with full credibility in the new regime. Such dating is nearly impossible to establish, however, as it would require a nearly infinite number of dating combinations for the large number of countries and potential dates to be included in our sample.

11. The dynamic properties and thus the importance of characteristics such as the ordering of the endogenous variables become relevant in the following sections.

12. The Kullback-Liebler distance is a measure of the distance from the maximum likelihood fit of the model; it is calculated as the sum (the integral) of the deviations of the maximum likelihood function evaluated at the estimated parameters from the true fit. This measure is usually used to evaluate the fit of a time-series model and is usually approximated by the Akaike information criteria (AIC). The AIC is inconsistent in that it picks larger-than-optimal lags. There are many ways to correct this, most commonly by penalizing the number of lags in the statistic. We use two such solutions: the Schwartz (SIC) and the Hannan-Quinn information criteria (HQIC).

13. This exercise is clearly not able to identify the effect of inflation targeting on credibility or the ability of the markets to predict inflation outcomes, which would require an identification strategy that could be consistently applied to all sample countries. We do not develop such a strategy but rather limit ourselves to a simple correlation exercise between inflation forecast errors and adoption of inflation targeting. However, we test for robustness below by changing country samples and the definition of inflation targeters.

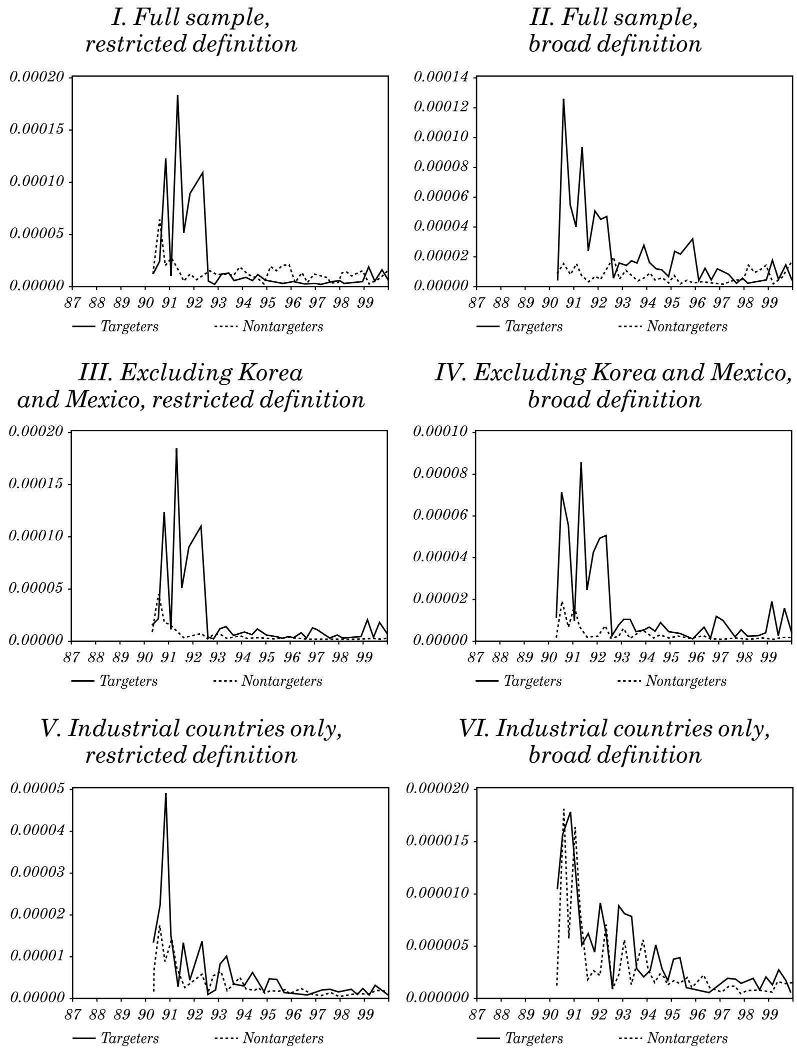
Figure 2. Average Quadratic Errors of Inflation Deviation Forecasts for Inflation Targeters and Nontargeters, Rolling VARs, 1990–99[a]



Source: Authors' calculations.

a. Obtained from out-of-sample forecasts of a rolling VAR and divided by the level of trend inflation, based on quarterly data. Under the restricted definition of inflation targeting, an inflation-targeting country is included in the group of targeters only in the periods in which it had inflation targeting in place; in all other periods, it is included among the nontargeters. Under the broad definition, the group of targeters includes every country that had inflation targeting in place during some period in 1980–99.

Figure 3. Average Quadratic Errors of Inflation Deviation Forecasts for Inflation Targeters and Nontargeters, Recursive VARs, 1990–99[a]



Source: Authors' calculations.

a. Obtained from out-of-sample forecasts of a recursive VAR and divided by the level of trend inflation, based on quarterly data. Under the restricted definition of inflation targeting, an inflation-targeting country is included in the group of targeters only in the periods in which it had inflation targeting in place; in all other periods, it is included among the nontargeters. Under the broad definition, the group of targeters includes every country that had inflation targeting in place during some period in 1980–99.

and V of each figure, an inflation-targeting country is included in the group of inflation targeters only in the periods in which it had inflation targeting in place; in all other periods, it is included among the nontargeters. In panels II, IV and VI, however, the group of inflation targeters includes every country that had inflation targeting in place during some period in 1990–99. Panels I and II represent the full country sample. Panels III and IV exclude Korea and Mexico because of high volatility during the sample period. Panels V and VI represent an even smaller sample of industrial countries only, thus excluding Chile and Israel.

The results suggest a positive effect of inflation targeting on the accuracy of inflation forecasts. We consistently observe that countries that adopted inflation targeting have converged to a level of accuracy similar to that observed in the control group of nontargeters. This convergence occurred towards 1994, despite the improved accuracy observed in the group of nontargeters. This convergence process was important for nonindustrial inflation-targeting countries, such as Chile, Israel, and Mexico. Furthermore, countries converging to steady-state inflation levels—rather than steady-state inflation targeters—enjoyed a bonus of higher accuracy (and presumably more credibility). Inflation targeters thus achieved a significant convergence of inflation expectations to their actual inflation rates in the last decade. The similarity of results reported in figures 2 and 3 supports the robustness of this conclusion.

Most of the time-series structure of the inflation errors has been removed from the VARs on which the quadratic inflation deviation forecast errors are based. We still find, however, that some time-series structure remains in the inflation series for some countries, as indicated by correlograms. Since we are not able to address this problem by including more lags, we filtered the resulting forecast errors by the time-series structure suggested by the correlograms, recalculating the group averages of quadratic inflation deviation forecast errors for inflation targeters and nontargeters. The exercise maintained the results of panels I through V, while the result corresponding to panel VI provides evidence of inflation expectations convergence. Whereas in figures 2 and 3 industrialized inflation targeters and nontargeters exhibit a similar reduction of forecast errors over the 1990s, the exercise showed a clear convergence of inflation targeters to nontargeters, as the latter had already achieved low forecast errors in the early 1990s.

To test the robustness of our results for one-quarter forecasts, we generated similar statistics to those reported in figures 2 and 3 for two to six-quarter forecasts. Our unreported results are similar to those shown above, confirming that the predictability of inflation is improved for the overall sample that includes emerging economies, for forecasts up to six quarters ahead. For the sample of industrialized inflation targeters (panel VI in figures 2 and 3), the result continues to stand for two-quarter-ahead forecasts of inflation. It does not hold, however, for longer inflation forecasts (three to six quarters), since inflation forecast errors are very similar for both inflation targeters and nontargeters. This may reflect the larger gains from adopting inflation targeting that accrue to emerging economies, in comparison with those reaped by mature industrialized economies that adopt inflation targeting among other available monetary regimes.

3. The Behavior of the Macroeconomy under Inflation Targeting

This section assesses whether inflation targeting has changed the structure of economies and their response to shocks, using the results of dynamic variance decompositions based on the rolling country VARs estimated in the preceding section.[14] We report the average share of the orthogonalized innovation of one variable in the variance of another variable using estimated VAR parameters and the orthogonalized components of each of the endogenous variables.[15] We report aggregate results for our samples of inflation targeters and nontargeters, for two different country samples: the full sample of twenty-three countries listed in section 1.1 and the smaller sample of seventeen industrial countries only (see figures 4 and 5).[16]

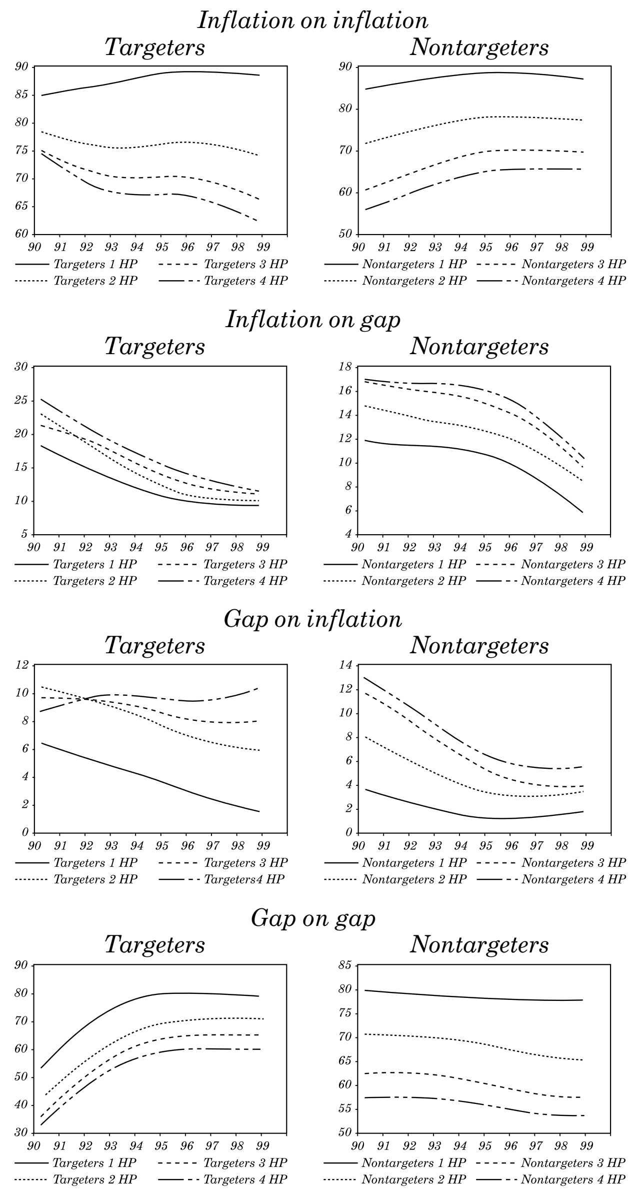
The figures show the shares of orthogonalized innovations in inflation and the output gap in the variance of inflation innovations, considering both own and cross innovations. Each figure separately reports the

14. Since we did not find major differences between rolling VARs and recursive VARs, here we perform the exercise on rolling VARs only to maximize observed changes in economic structure.

15. The variance decomposition presents a dynamic simulation of the estimated system in which a shock to an endogenous variable is separated into the orthogonal component shocks to the endogenous variables of the VAR. As usual, the orthogonalized errors are constructed decomposing the estimated errors according to a Cholesky decomposition of the variance-covariance matrix. The variance decomposition provides information about the relative importance of each random innovation to each variable in the VAR, describing the reduced-form effects and trade-offs that are present in an economy. If the VAR model is an adequate description of the economy, it will provide the reduced-form response of the macroeconomy that combines the interplay of private and public sector actions, including the monetary policy reactions of the central bank.

16. The smaller sample comprises the twenty-three countries listed in section 1.1 less Chile, Colombia, Israel, Korea, Mexico, and South Africa.

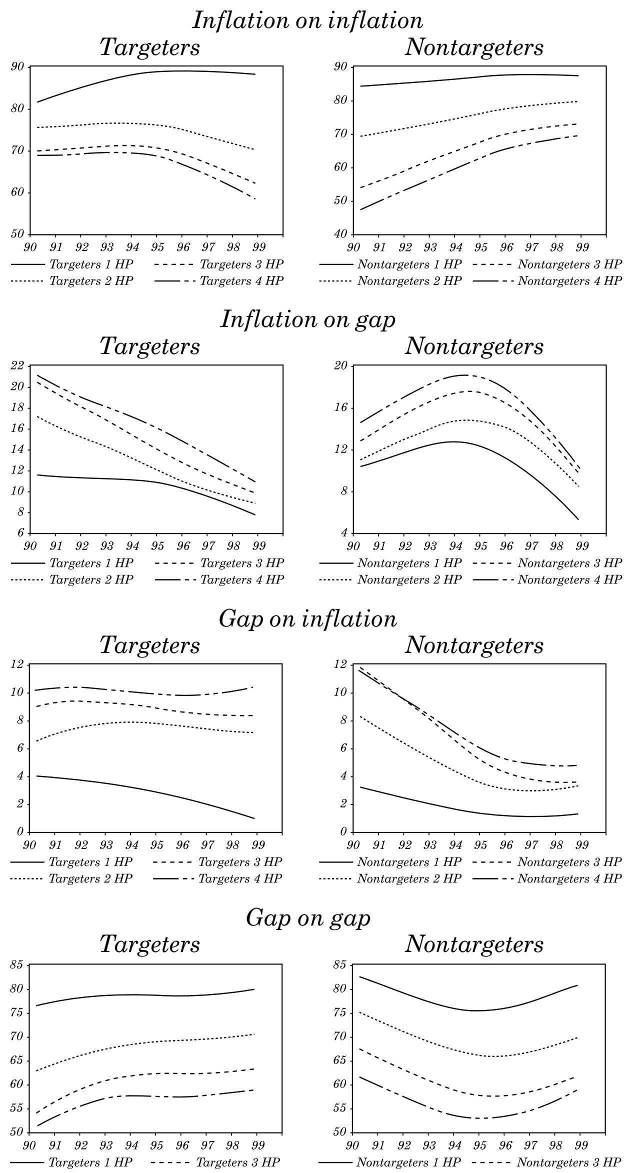
Figure 4. Dynamic Variance Decomposition for Inflation and Output Gaps, Full Sample, 1990–98[a]



Source: Authors' calculations.

a. Obtained from out-of-sample forecasts of a rolling VAR, based on quarterly data.

Figure 5. Dynamic Variance Decomposition for Inflation and Output Gaps, Industrial Countries, 1990–98[a]



Source: Authors' calculations.

a. Obtained from out-of-sample forecasts of a rolling VAR, based on quarterly data.

dynamic variance decomposition effects for the four different lags included in the VARs. The results for rolling VARs are given for fixed windows of forty quarters (depending on availability of data per country VAR), starting with 1980:1–1989:4 and ending with 1990:1–1999:4.

The results show revealing commonalties and differences across country groups and over time. An innovation in the first inflation lag (reflecting first-order inflation persistence) shows some increase over time but not much difference across country groups of inflation targeters and nontargeters. However, the role of innovations in higher-order lags on inflation has fallen among inflation targeters, on average, but increased among nontargeters—for both sample definitions. This suggests that inflation targeting partly substitutes forward-looking inflation expectations (influenced by the official inflation target) for the backward-looking roots of the inflation process.

We do not find differences between inflation targeters and nontargeters regarding the cross-effects of inflation shocks on output gap variances. In both country groups, the effects are small, and they tended to decrease during the 1990s. More significant differences emerge between both country groups when we examine the opposite cross effect from inflation innovations to output gap variances. Among inflation targeters, a large reduction in the impact of inflation innovations on output variance took place in the 1990s, falling closer to the levels of nontargeters. Inflation targeting may thus have contributed to anchoring inflation expectations and helping to isolate the output gap from inflation innovations.

A third and final difference among country groups is observed in the effect of lagged output gap innovations on the current output gap variance. On average, output persistence increased by a sizable amount at every lag among inflation targeters throughout the 1990s, reaching levels comparable to those of nontargeters, whose output persistence did not change much during the decade.

The effect of innovations in the nominal exchange rate on inflation variance can be interpreted as the reduced-form pass-through from devaluation to inflation. No major differences are observed either at the aggregate level of country samples or over time.[17]

17. Some interesting results were obtained at the country level, however, for the two transition inflation targeters that have converged to steady-state inflation during the 1990s: Chile and Israel. They show a decline in the share of exchange rate innovations in inflation variance during the decade. This result supports the notion that the devaluation-inflation pass-through has declined in both countries during the 1990s, as a result of recent (Chile) or ongoing (Israel) convergence toward a flexible exchange rate regime and the achievement of stationary inflation in both countries.

Finally, no major differences between inflation targeters and nontargeters are observed for the effects of innovations in or on other variables, with the exception of the effects of innovations on interest rates, which are discussed in section 5.

4. The Effect of Inflation Targeting on Central Bank Aversion to Inflation

Cecchetti and Ehrmann (2002) develop a simple, useful model to derive and measure the aversion of central bankers to inflation variability relative to their aversion to output variability. By maximizing a standard quadratic loss function subject to linear aggregate supply and aggregate demand equations, they derive the following equation that relates the relative aversion to inflation variability, α, to the slope of the aggregate supply curve, γ, and the variance of inflation, σ_π^2, and output, σ_y^2:

$$\frac{\sigma_y^2}{\sigma_\pi^2} = \left(\frac{\alpha}{\gamma(1-\alpha)} \right)^2 . \qquad (1)$$

Cecchetti and Ehrmann calculate the inflation-aversion coefficient, α, using equation 1 and country data for inflation and output variances and estimating aggregate supply slopes from impulse response functions that derive the output effects of demand shocks. They generate country-by-country results based on quarterly data for the 1980s and 1990s for nine inflation targeters and fourteen nontargeters, On that basis, they conclude that the inflation aversion of inflation targeters is not higher, on average, than in the control group of nontargeters. By using rolling regressions for shorter subsamples, however, they also find that inflation aversion increased significantly in most inflation targeters shortly before, during, or after the adoption of inflation targeting.

When we performed Cecchetti and Ehrmann's calculation for our samples of inflation targeters and nontargeters, we departed from their empirical procedures in four important ways. First, our sample differs from theirs in country composition and time coverage. With regard to the latter, our quarterly sample extends from 1980 through 1999, which is longer than theirs. Second, Cecchetti and Ehrmann define the deviation of inflation (and the corresponding variance) relative to a constant 2 percent annual inflation rate, while we define it as the deviation from an estimated Hodrick-Prescott (HP) trend for nontargeters (as discussed in section 2) or the deviation from inflation target levels for targeters. This has important consequences for the time-varying measures of inflation variance, as discussed below. Third, we reestimate output supply slopes from impulse response functions based on the country VARs run in section 2 and add alternative estimates based on simple Phillips-curve estimations. Finally, we reestimate inflation and output variances from our country samples.

Our results of cumulative impulse responses of output to interest rate shocks at quarterly leads, ranging from one to thirteen quarters, show a wide range of period and country responses, from large positive to large negative supply slopes. The time averages over the thirteen lead responses for each country (excluding the 5 percent tails of the cross-country time-series distribution) vary between –7.2 (France) and 10.7 (the Netherlands). We rescale the latter ordering linearly to obtain a ranking of output slope coefficients in the range spanned from 0.1 to 6.0.

As an alternative to the previous results we estimate supply slope coefficients from the two following variants of the simple Phillips curve:

$$y\text{GAP}_t = \delta_0 + \delta_1(\pi_t - \pi_{t-1}) \text{ and} \quad (2)$$

$$y\text{GAP}_t = \delta_0 + \delta_1(\pi_t - E_{t-1}\pi_t), \quad (2')$$

where last period's expectation of current inflation is obtained from our out-of-sample inflation forecasts reported in section 2.

Two measures for the output gap (yGAP) were derived, based on the deviations from HP trend levels of GDP and industrial output. The combinations of equations and output measures were estimated by ordinary and two-stage least squares.[18] The sample period extends from 1980 to 1999, using quarterly data. The eight slope coefficients for the corresponding combinations of equations, output measures, and estimation techniques vary widely by estimated equation and country. We again linearly rescaled the averages for each country for the eight estimations (outliers were defined as observations in the 5 percent tails), obtaining slope coefficients in the 0.1 to 6.0 range.

The first four columns in table 8 report supply slope coefficients (γ) according to four available measures: Cecchetti and Ehrmann's origi-

18. For the two-stage least squares estimations the interest rate was used as the instrument for the inflation deviation, to be consistent with the VAR impulse response estimates.

nal average cross-country measure (2.83); Cecchetti and Ehrmann's original individual country measure for those countries included by Cecchetti and Ehrmann or 2.83 for the excluded countries; our first country measure from VAR impulse responses; and our second country measure from Phillips curves. The output slopes vary considerably across countries. The variation is smaller across our three country groups, although the γ_s appear to be consistently higher, on average, in inflation targeters than in potential inflation targeters and nontargeters.

Finally, table 8 also lists the country inflation aversion coefficients (α) obtained by applying equation 1, based on the γ_s shown in the table and on country output and inflation variances. Our estimates for α are much higher, on average, than Cecchetti and Ehrmann's figures, reflecting the fact that our inflation variance is much lower, as discussed above. The average α is close to 0.91 across different measures and countries. There are no differences in α_s between inflation targeters, potential inflation targeters, and nontargeters, which confirms Cecchetti and Ehrmann's result.

Next we investigate whether the relative aversion to inflation changed over the 1990s. Like Cecchetti and Ehrmann, we focus on time-varying country estimates of inflation aversion coefficients from rolling five-year windows. To minimize contamination from mismeasurement of output supply coefficients, we use a common γ for all countries (2.83, obtained directly from Cecchetti and Ehrmann). Our discussion centers on the time pattern of α_s starting about 1990 (and thus with five-year windows before 1991) because much noise characterized policies and outcomes until the mid-1980s.

Inflation aversion rose during the 1990s in many countries across various groups. Among inflation targeters, revealed inflation aversion rose significantly in Chile, Finland, Israel, and Sweden. Inflation aversion also increased significantly among many nontargeters in the 1990s, including Denmark, France, Germany, the Netherlands, Norway, Switzerland, and the United States. Such a trend is not observed among potential inflation targeters; in fact, α_s declined in Brazil and Mexico during the decade. Many of these country results differ significantly from those reported by Cecchetti and Ehrmann.

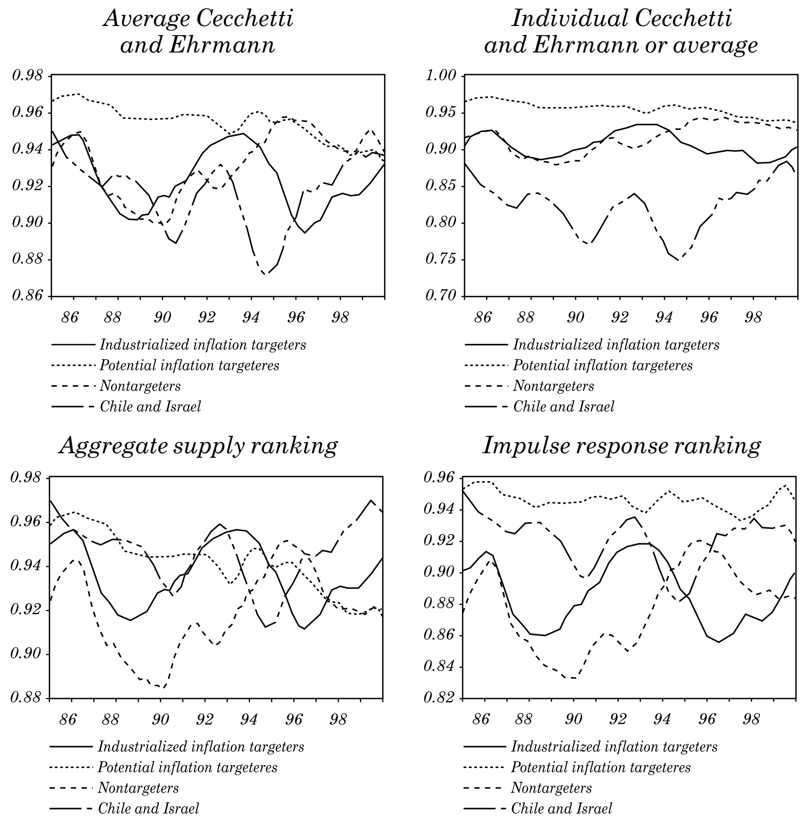
Figure 6 plots aggregate dynamic inflation aversion coefficients (α) for four country groups and our four alternative estimates for output supply coefficient γ, based on five-year estimation windows and our inflation variances. The country group results are quite robust across different γ estimates. The average α of the subgroup of industrialized inflation

Table 8: Estimates of Central Bank Inflation Aversion: Robustness Exercise

	Supply slope coefficient (γ)				*Inflation aversion coefficients (α)*			
Country	*Average Cecchetti and Ehrmann*	*Individual Cecchetti and Ehrmann or average*	*Ranking of aggregate supplies*	*Ranking of impulse responses*	*Average Cecchetti and Ehrmann*	*Individual Cecchetti and Ehrmann or average*	*Ranking of aggregate supplies*	*Ranking of impulse responses*
Inflation targeters	**2.83**	**3.39**	**3.83**	**2.63**	**0.92**	**0.89**	**0.94**	**0.89**
Australia	2.83	4.65	3.71	2.80	0.88	0.92	0.90	0.88
Canada	2.83	1.80	2.71	2.72	0.93	0.90	0.93	0.93
Chile	2.83	0.84	6.00	2.73	0.95	0.85	0.98	0.95
Finland	2.83	3.76	3.14	1.68	0.94	0.95	0.94	0.90
Israel	2.83	1.42	4.07	3.23	0.88	0.79	0.92	0.90
New Zealand	2.83	0.67	3.25	0.60	0.92	0.74	0.93	0.72
Spain	2.83	1.22	4.59	5.65	0.96	0.90	0.97	0.98
Sweden	2.83	2.35	3.33	1.91	0.94	0.93	0.95	0.92
United Kingdom	2.83	13.76	3.70	2.34	0.89	0.97	0.91	0.87
Potential inflation targeters	**2.83**	**2.83**	**2.77**	**2.18**	**0.94**	**0.94**	**0.94**	**0.93**
Colombia	2.83	2.83	3.43	1.19	0.97	0.97	0.98	0.94
Korea	2.83	2.83	3.40	1.75	0.92	0.92	0.93	0.87
Mexico	2.83	2.83	1.90	2.70	0.91	0.91	0.88	0.91
South Africa	2.83	2.83	2.34	3.07	0.97	0.97	0.97	0.98
Nontargeters	**2.83**	**3.24**	**2.66**	**2.53**	**0.93**	**0.91**	**0.92**	**0.87**
Denmark	2.83	0.70	3.29	2.32	0.94	0.80	0.95	0.93
France	2.83	6.15	2.59	0.10	0.94	0.97	0.93	0.41
Germany	2.83	5.72	2.57	1.61	0.91	0.95	0.90	0.85
Italy	2.83	4.89	2.25	2.90	0.94	0.97	0.93	0.95
Japan	2.83	1.09	3.16	2.38	0.94	0.87	0.95	0.93
Netherlands	2.83	2.03	2.96	6.00	0.91	0.88	0.91	0.95
Norway	2.83	2.83	3.10	2.73	0.93	0.93	0.94	0.93
Portugal	2.83	2.83	2.19	2.89	0.95	0.95	0.94	0.95
Switzerland	2.83	5.08	1.42	2.52	0.92	0.95	0.86	0.91
United States	2.83	1.10	3.12	1.90	0.92	0.83	0.93	0.89

Source: Authors' estimations.

Figure 6. Dynamic Inflation Aversion Coefficients



Source: Authors' calculations.

targeters does not exhibit any time trend during the 1990s, although there are cyclical swings. However, inflation aversion exhibits an upward trend in the two transition inflation targeters—Chile and Israel—since 1990. Although α declines temporarily in the mid-1990s, which largely reflects a strong temporary decline in Israel, the average α is 4 percentage points higher in the late 1990s than around 1990.

The group of nontargeters also exhibits a trend rise in inflation aversion in the 1990s, and also by a magnitude close to 4 percentage points. The only group that shows a trend decline in their inflation aversion is the potential inflation targeters, by an average total reduction of about 2 percentage points.

Our results for time trends of aversion coefficients are thus strikingly different from Cecchetti and Ehrmann's. Only transition inflation targeters (Chile and Israel) show a trend increase in their α_s during the 1990s. In this respect, they behave similarly to other industrialized nontargeters, rather than to other inflation targeters.

5. How Inflation Targeting Affects Central Bank Behavior

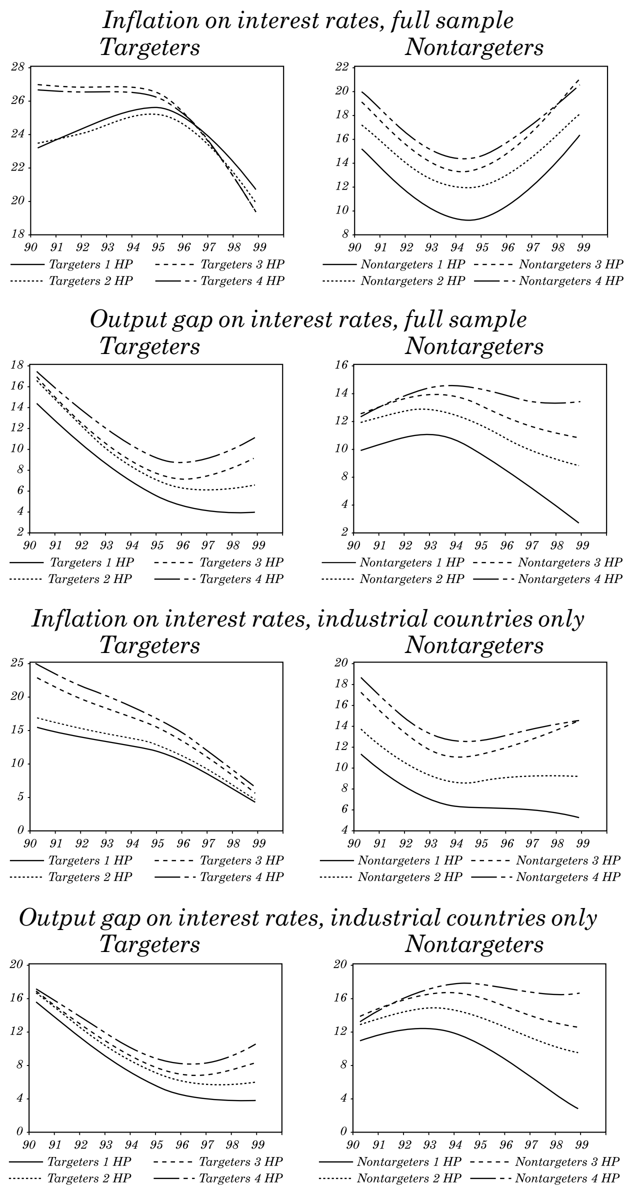
This section analyzes whether the behavior of central banks in setting their policy instrument, namely, the interest rate, differs in inflation targeters and nontargeters. We approach this question from two angles. First, we report the results of inflation and output innovations on the variance of interest rates, based on dynamic variance decompositions performed on the rolling VARs estimated in section 2. Second, we report econometric results for simple Taylor policy rules to infer the weights of inflation and output gaps in the evolution of short-term interest rates.

Figure 7 presents the dynamic variance decomposition for the gap and inflation pressure on the interest rate. The two top panels are for the full samples of inflation targeters and nontargeters, while the two bottom panels are for the industrial-country subsamples of inflation targeters and nontargeters. Inflation targeters were able to lower the reaction of the interest rate to innovations in both inflation and the gap during the 1990s. This result is robust to the inclusion or exclusion of nonindustrial countries in the groups of inflation targeters and nontargeters. It suggests that inflation targeters have gradually gained credibility, which allows them to achieve their inflation targets with gradually smaller changes in interest rates. Among nontargeters, however, the impact of inflation innovations on interest rates did not decline in the 1990s, although they show some decline in the effect of output gap innovations on interest rates at the first and second lags.

Next we estimate a simple Taylor rule consistent with a reduced-form partial-adjustment equation for the reaction of the central bank to inflation and output gaps.[19] This equation is consistent with a central bank that determines its policy rate, r, as a weighted average of the one-period lagged rate and the optimal rate. The latter is a function

19. On the robustness of simple Taylor rules, see Taylor (2000).

Figure 7. Dynamic Variance Decomposition for Interest Rates, 1990-1998[a]



Source: Authors' calculations.

a. Obtained from out-of-sample forecasts of a rolling VAR, based on quarterly data.

of both contemporaneous gaps, giving rise to the following reduced-form equation:

$$r_t = \delta_0 + \delta_1 r_{t-1} + \delta_2 \pi\text{GAP}_t + \delta_3 y\text{GAP}_t \qquad (3)$$

where πGAP_t (the inflation gap) is the difference between actual and target inflation for inflation targeters and between actual and trend inflation for nontargeters, and $y\text{GAP}_t$ (the output gap) is the difference between actual and trend industrial output. Expected coefficient signs are positive.

Quarterly data for the 1990–99 period are used for each country. Country-by-country ordinary least squares (OLS) results for equation 3 are reported in table 9. The only result that is common across most countries is that the lagged quarterly interest rate coefficient is numerically close to 1, reflecting a high degree of monetary policy inertia. There are thus proportionally large differences between short- and long-term effects of the inflation gap and the output gap on interest rates. While most gap coefficients are positive, as expected, they exhibit large cross-country variation in their sizes, and not many are significantly different from zero.

The interest rate is a nominal rate in all countries, except Chile. In all countries with nominal interest rates, the coefficient of the short-term inflation gap is smaller than 1, signaling that central banks raise nominal interest rates by less than a contemporaneous increase in inflation. In the case of Chile, the estimated coefficient of less than 1 is consistent with a coefficient of 1 plus the estimate under nominal interest rates. These results are similar to previous findings on Taylor rule estimations for various countries (Restrepo, 1998; Taylor, 2000; Corbo, 2002).

The long-term inflation gap coefficient is positive and significantly different from zero in three inflation targeters (Australia, Israel, and the United Kingdom), four nontargeters (Japan, the Netherlands, Portugal, and the United States), and three potential inflation targeters (Brazil, Colombia, and Korea). Country output gap coefficients are positive in most countries and positive and significantly different from zero in ten countries. Among the three groups, inflation targeters exhibit the largest inflation gap coefficients, on average, relative to the output gap coefficients.

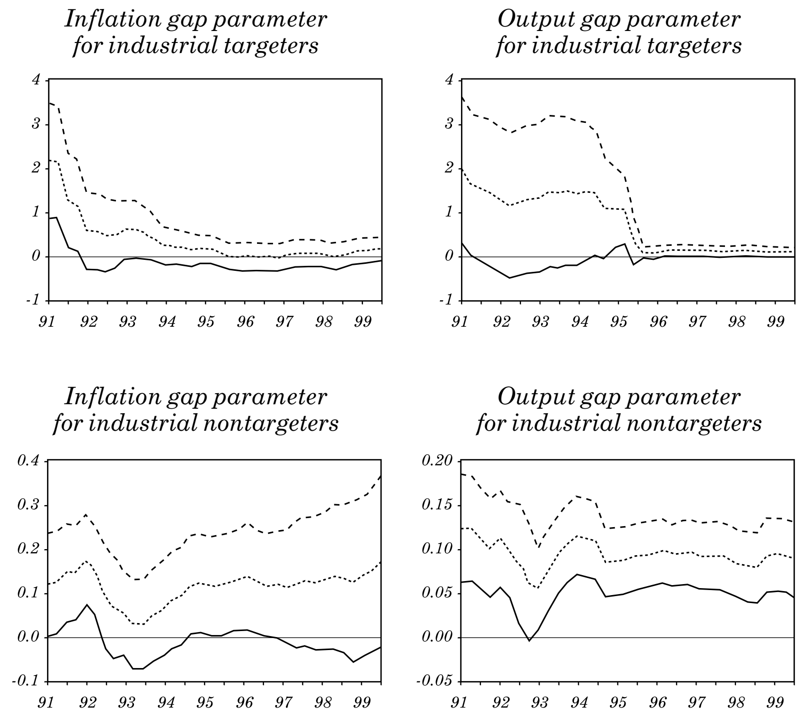
Next we perform rolling estimations of country Taylor rules for ten-year windows. The regressions are performed for the same samples of total inflation targeters and nontargeters for which the variance decompositions for interest rates were reported in figure 7. The inflation

Table 9. Estimation Results of Simple Taylor Rules for Inflation Targeters and Nontargeters, 1990:1–1999:4[a]

Country	*Lagged interest rate*	*Inflation gap*[b]	*Activity gap*[c]	*Adjusted* R^2
Nontargeters				
Denmark	0.94*	0.06	0.12	0.81
	(0.09)	(0.95)	(0.13)	
France	0.97*	–0.12	0.07*	0.98
	(0.02)	(0.11)	(0.02)	
Germany	0.98*	0.04	0.10*	0.99
	(0.01)	(0.03)	(0.01)	
Italy	0.94*	0.27	0.02	0.85
	(0.08)	(0.32)	(0.09)	
Japan	0.98*	0.09**	0.02	0.99
	(0.02)	(0.06)	(0.01)	
Netherlands	0.97*	0.34**	0.08**	0.97
	(0.03)	(0.21)	(0.05)	
Norway	0.82*	–0.51	0.09	0.67
	(0.10)	(0.69)	(0.14)	
Portugal	0.98*	0.36*	0.02	0.98
	(0.03)	(0.14)	(0.06)	
Switzerland	0.95*	0.12	0.07**	0.96
	(0.04)	(0.12)	(0.04)	
United States	0.78*	0.21*	0.22*	0.97
	(0.04)	(0.08)	(0.03)	
Inflation targeters				
Australia	0.79*	0.17*	0.09*	0.98
	(0.03)	(0.06)	(0.04)	
Canada	0.97*	–0.14	0.17*	0.92
	(0.05)	(0.12)	(0.06)	
Chile	0.65*	0.68	0.00	0.40
	(0.13)	(1.05)	(0.41)	
Finland	0.97*	0.17	0.01	0.98
	(0.04)	(0.11)	(0.03)	
Israel	0.71*	0.23*	–0.19	0.80
	(0.08)	(0.08)	(0.13)	
New Zealand	0.92*	–0.07	0.17*	0.86
	(0.08)	(0.17)	(0.08)	
Spain	0.99*	0.27	0.05	0.97
	(0.03)	(0.25)	(0.05)	
Sweden	0.54*	0.26	0.04	0.26
	(0.16)	(0.38)	(0.24)	
United Kingdom	0.87*	0.27*	0.04	0.97
	(0.04)	(0.11)	(0.08)	
Potential inflation targeters				
Colombia	0.85*	0.62*	0.08	0.76
	(0.09)	(0.19)	(0.15)	
Korea	0.68*	0.56*	0.09	0.60
	(0.15)	(0.28)	(0.09)	
Mexico	0.59*	–0.07	–0.94	0.57
	(0.14)	(0.16)	(0.51)	
South Africa	0.80*	0.12	0.13**	0.81
	0.08	0.14	0.08	

Source: Authors' calculations.
a. Standard errors are in parentheses.
b. As a deviation from an HP1600 trend.
c. Annualized deviations from inflation target or an HP1600 trend.
* Significant at the 5 percent level.
** Significant at the 10 percent level.

Figure 8. Rolling Taylor Rule Coefficients, Full Sample: 1990:1–1999:4[a]

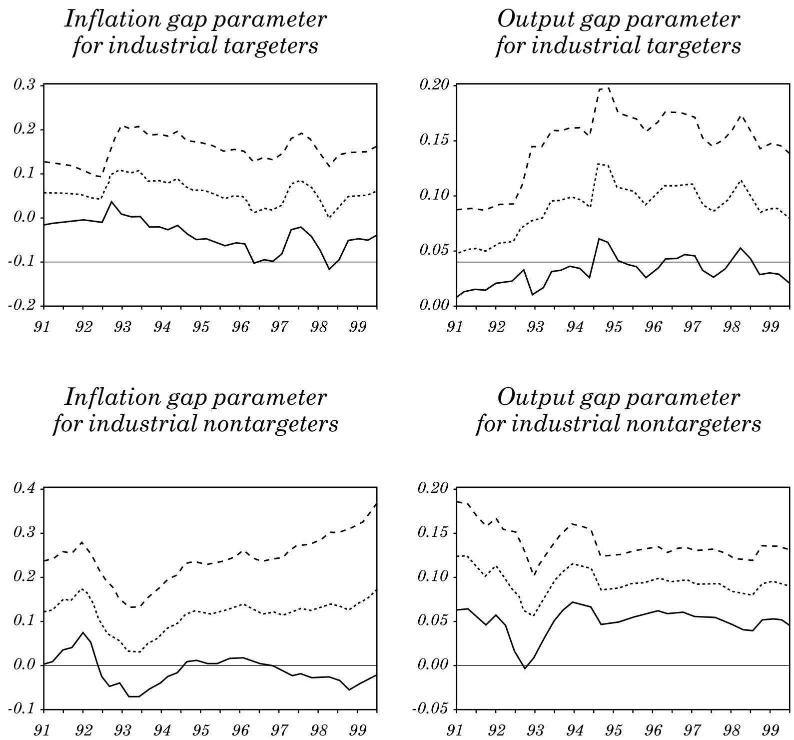


Source: Authors' calculations.

a. Taylor rule estimated with contemporary inflation and activity as independent variables. The sample of industrial targeters includes Chile and Israel.

and output gap coefficients have declined consistently among inflation targeters—but this is due to the inclusion of the two transition inflation targeters (Chile and Israel) in the full sample of inflation targeters (figure 8). When the latter countries are excluded, thereby restricting the inflation targeting sample to industrial countries, neither coefficient exhibits a downward trend in the 1990s (figure 9). The same lack of any trend is observed among nontargeters. These results confirm that transition inflation targeters (Chile and Israel) gradually established credibility, initially requiring larger changes in interest rates in response to inflation or output shocks than have been necessary since the mid-1990s, when the two countries had firmly established their inflation-targeting regimes and inflation was lower.

Figure 9. Rolling Taylor Rule Coefficients, Excluding Chile and Israel: 1990:1–1999:4[a]



Source: Authors' calculations.

a. Taylor rule estimated with contemporary inflation and activity as independent variables. The sample of industrial targeters includes Chile and Israel.

6. Does the Introduction of Inflation Targeting Make a Difference? A Case Study of Chile [20]

Chile was the first developing country to implement inflation targeting, and it was the first to complete its transition toward a full-fledged inflation-targeting framework and to converge to stationary inflation. Using a small dynamic macroeconomic model for Chile, we study whether inflation targeting has contributed to reducing inflation

20. This section draws on Corbo and Schmidt-Hebbel (2000).

and made a difference in the speed and cost of price stabilization. We also investigate the main channels through which inflation targeting could contribute to reduce inflation. In this framework, inflation targeting affects inflation dynamics through its effect on inflation expectations. The latter variable, in turn, affects price and wage dynamics.

The model extends that developed by Corbo (1998) by introducing inflation expectations (measured as the difference between nominal and real interest rates on similar instruments), which explicitly enter the wage and inflation equations. Inflation expectations are specified as a linear combination of a four-quarter moving average of preceding inflation, the inflation target, and the inflation forecast error.

The full model is given by the following equations:

$$\begin{aligned}\pi_t^S &= \alpha_0 + \alpha_1\omega_t + \alpha_2\hat{e}4_t + \alpha_3\mathrm{GAP}_{t-1} + \alpha_4\mathrm{D2} \\ &\quad + \alpha_5\mathrm{D3} + \alpha_6\mathrm{D4} + \alpha_7\pi_t^E + \alpha_8\pi_t^*,\end{aligned} \tag{4}$$

$$\omega_t = \beta_0 + \beta_1\pi_t^E + \beta_2\pi_{t-2} + \beta_3\mathrm{D2} + \beta_4\mathrm{D3}, \tag{5}$$

$$\mathrm{GAP}_t = \gamma_0 + \gamma_1\mathrm{GAP}_{t-1} + \gamma_2\mathrm{TOT}_t + \gamma_3\mathrm{PRBC}_{t-2} + \gamma_4\mathrm{KGDP}_t \times \mathrm{D96}, \tag{6}$$

$$\mathrm{UNEMP}_t = \delta_0 + \delta_1\mathrm{GAP}_t + \delta_2\mathrm{UNEMP}_{t-1} + \delta_3\mathrm{D2} + \delta_4\mathrm{D3} + \delta_5\mathrm{D4}, \tag{7}$$

$$\mathrm{CAD}_t = \chi_0 + \chi_1\mathrm{GAP}_t + \chi_2\mathrm{CAD}_{t-1}, \tag{8}$$

$$\hat{e}_t = \phi_0 + \phi_1\pi_{t-1} + \phi_2\pi_{t-1}^* + \phi_3\Delta\mathrm{FRES}_t + \phi_4\mathrm{DEV}_t + \phi_5\mathrm{KGDP}_t \times \mathrm{D96}, \tag{9}$$

$$\begin{aligned}\pi_{t+1}^E &= \mu_0 + \mu_1\mathrm{TAR}_{t+4} + \mu_2\left[(\pi_t + \pi_{t-1} + \pi_{t-2} + \pi_{t-3})/4\right] \\ &\quad + \mu_3\left[(\pi_t + \pi_{t-1} + \pi_{t-2} + \pi_{t-3})/4 - \pi_{t-4}^E\right], \text{ and}\end{aligned} \tag{10}$$

$$\pi_t = \lambda_0 + \lambda_1\pi_t^S + \lambda_2\mathrm{D3} + \lambda_3\mathrm{D4} + \lambda_4\mathrm{A93} + \lambda_5\mathrm{A94} + \lambda_6\mathrm{A96} + \lambda_7\mathrm{A98}, \tag{11}$$

where π_t^S is the quarterly rate of change of core inflation; π_t is the quarterly rate of change of headline CPI inflation; π_{t-1}^E is the expected quarterly rate of headline CPI inflation for period $t + 1$, based on information available at period t; ω_t is the quarterly rate of change of the wage rate; $\hat{e}_t$ is the quarterly rate of change of the nominal exchange rate, in

Chilean pesos per U.S. dollar; $\hat{e}4_t$ is the four-quarter moving average of $\hat{e}_t$; π_t^* is the quarterly rate of change in international inflation, in U.S. dollars; GAP_t is the gap between the seasonally adjusted quarterly GDP and its trend, as a percentage of the trend, measured by applying the Hodrick-Prescott filter; TOT_t is the four-quarter moving average of the log of the terms of trade; $PRBC_t$ is the real annual interest rate of Central Bank ninety-day debt paper (the PRBC-90); $KGDP_t$ is capital inflows as a percentage of nominal GDP; $UNEMP_t$ is the quarterly unemployment rate; CAD_t is the current account deficit of the year ending in quarter *t*, as percentage of nominal GDP; $FRES_t$ is the quarterly change in Central Bank foreign reserves, in US dollars; DEV_t is the difference between the log of the market nominal exchange rate and the log of the central parity of the exchange rate band; TAR_t is the quarterly inflation rate implicit in the inflation target announced by the Central Bank;[21] D2, D3, and D4 are seasonal dummies for the second, third, and fourth quarter, respectively; D96 is a dummy variable that takes a value of 1 from the first quarter of 1996 to the sample end (the third quarter of 2000), to control for the sharp change in capital inflows; and A93, A94, A96, and A98 are dummy variables that take a value of 1 for 1993, 1994, 1996, and 1998, respectively, for specific supply shocks that could affect the difference between core and headline CPI inflation.

Equation 4 for core inflation is specified as the weighted average of inflation equations for tradable and nontradable goods and services, including expected inflation. Equation 5 for wage inflation includes lagged inflation to reflect backward indexation schemes in wage contracts and expected inflation to reflect forward-looking wage contracts. Equation 6 for the output gap is a function of its own lag, the terms of trade, the lagged value of the real interest rate, and capital inflows. Equation 7 relates the unemployment rate to the output gap (Okun's law). Equation 8 for the ratio of the current account deficit to GDP is a function of the output gap and its lagged value. Equation 9 describes the nominal exchange rate devaluation within the exchange rate band that was in place until late 1999. Equation 10 relates expected inflation to the forward-looking inflation target, a moving average of lagged inflation levels, and an inflation forecast error term. Equation 11 relates actual inflation to core inflation and also introduces seasonal dummies and annual dummies for particular weather and oil-related shocks. Model estimation results are reported in table 10.

21. Computed by linearizing the annual inflation target announced as the December-to-December rate of change.

Table 10. Estimated Model Coefficients for Chile[a]

Equation and parameter	*Estimated value*	*Standard error*	*Equation and parameter*	*Estimated value*	*Standard error*
Equation 4			Equation 9		
α_0	–0.632	0.363	ϕ_0	–0.326	1.059
α_1	0.432	0.119	ϕ_1	0.379	0.191
α_2	0.141	0.041	ϕ_2	–0.070	0.116
α_3	0.105	0.048	ϕ_3	–0.002	0.0005
α_4	1.394	0.325	ϕ_4	–0.245	0.097
α_5	0.686	0.344	ϕ_5	–0.079	0.060
α_6	0.517	0.307	$R^2 = 0.42$		
α_7	0.285	0.135	Equation 10		
α_8	0.141	0.041	μ_0	0.426	0.082
$R^2 = 0.80$			μ_1	1	–
Equation 5			μ_2	0	–
β_0	1.378	0.186	μ_3	0.125	0.074
β_1	0.826	0.099	$R^2 = 0.79$		
β_2	0.174	–	Equation 11		
β_3	–1.221	0.347	λ_0	–0.347	0.249
β_4	–1.249	0.326	λ_1	1.078	0.123
$R^2 = 0.75$			λ_2	0.982	0.212
Equation 6			λ_3	1.093	0.214
γ_0	1.621	1.074	λ_4	–0.711	0.355
γ_1	0.675	0.093	λ_5	–0.762	0.300
γ_2	0.059	0.022	λ_6	–0.617	0.276
γ_3	–0.427	0.149	λ_7	–0.702	0.271
γ_4	0.055	0.041	$R^2 = 0.82$		
$R^2 = 0.70$			Equation 12		
Equation 7			ψ_0	6.718	0.281
δ_0	1.292	0.314	ψ_1	0.628	0.140
δ_1	–0.126	0.032	ψ_2	0.361	0.097
δ_2	0.843	0.038	ψ_3	5.055	0.119
δ_3	0.604	0.197	ρ	0.563	0.048
δ_4	0.207	0.204	$R^2 = 0.76$		
δ_5	–1.214	0.205			
$R^2 = 0.92$					
Equation 8					
χ_0	–0.278	0.133			
χ_1	0.219	0.043			
χ_2	0.850	0.033			
$R^2 = 0.88$					

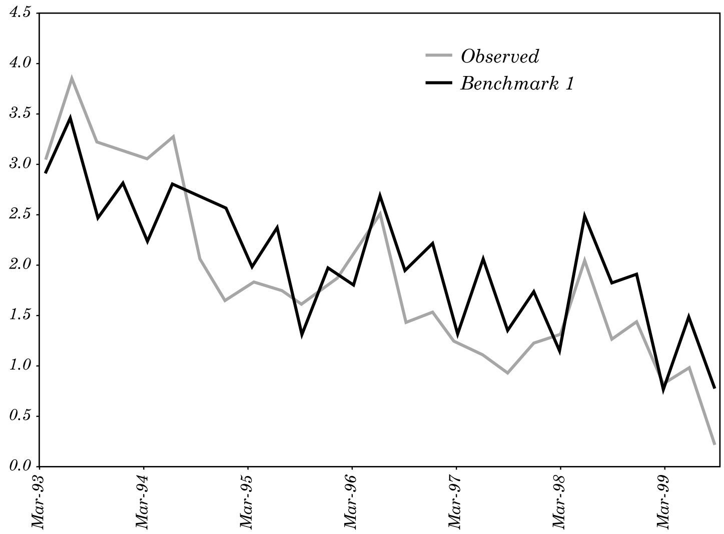
Source: Authors' estimations.

a. Based on inflation expectations estimated from the difference between nominal and real interest rates. The values presented here were used for the simulations and the counterfactuals. All the restrictions over the coefficients were tested before they were imposed, including homogeneity of degree one of all nominal variables in the price and wage equations (equations 4 and 5, respectively).

We now proceed to compare simulated values (obtained from the model's dynamic simulation) and actual values for core inflation. In the first simulation we take the actual real interest rate as given. Fig-

Figure 10. Core Inflation: Observed and Benchmark 1

Quarterly rate of change, in percent



Source: Authors' calculations.

ure 10 depicts the simulated values (noted as benchmark 1 values) and observed values for core inflation during 1993–99. Model simulations are close to actual values.

The first counter-factual simulation, which uses the benchmark 1 values, shows the path of core inflation that would have been observed if the inflation target had not been made public and therefore had not affected expectations.[22] In other words, we simulate the dynamic response of the Chilean economy if inflation expectations in the 1990s had been formed in the way they were formed in the 1980s. The comparison of simulated values (called nontarget expectations) with benchmark 1 values is presented in figure 11. Simulated values are almost always above benchmark values. These results support the hypothesis that introducing explicit inflation targets helped reduce inflation. The mechanism at work is the effect of the inflation target on inflation expectations, and of the latter on wage inflation and core price inflation.

22. For this purpose, we first estimate an equation for inflation expectations for the period before the introduction of inflation targeting (until the fourth quarter of 1990) and use this equation to model inflation expectations in the 1990s.

Figure 11. Core Inflation: Benchmark 1 and Nontarget Expectations Simulation

Quarterly rate of change, in percent

Source: Authors' calculations.

A clearer picture emerges when we compare the benchmark 1 values with the cumulative sum of quarterly inflation rates over four quarters, obtained by the nontarget expectations simulation (see table 11). A clear break occurred in 1996, when benchmark 1 inflation levels (based on inflation expectations influenced by the inflation target) start to fall well below conterfactual simulation values.[23] The inflation target thus appears to have affected actual inflation only some time after the introduction of inflation targeting, probably because at early stages of inflation targeting the public was still uncertain about the Central Bank's commitment to attaining the target.

To address the issue of macroeconomic effects of alternative stabilization paths, we run two counter-factual simulations for the speed and intensity of price stabilization in the 1990s: a more gradualist disinflation

23. This break coincided with the Central Bank's announcement in September 1995 of a more aggressive target of 6.5 percent for 1996. (For 1995 the target had been set at 9 percent and actual inflation was 8.2 percent.)

Table 11. Core Inflation in Chile: Benchmark 1 and Nontarget Expectations Simulation[a]

Date	*Benchmark*	*Simulation*
December 1993	11.6	12.9
June 1994	10.3	11.5
December 1994	10.2	10.9
June 1995	9.6	10.0
December 1995	7.6	8.6
June 1996	7.7	9.2
December 1996	8.6	10.4
June 1997	7.5	9.5
December 1997	6.4	8.9
June 1998	6.6	9.4
December 1998	7.3	10.0
June 1999	5.9	8.5

Source: Authors' calculations, based on model simulations.
a. Four-quarter sum of quarterly percentage rates of core CPI change.

Table 12. Actual and Counterfactual Paths for the Inflation Target in Chile[a]

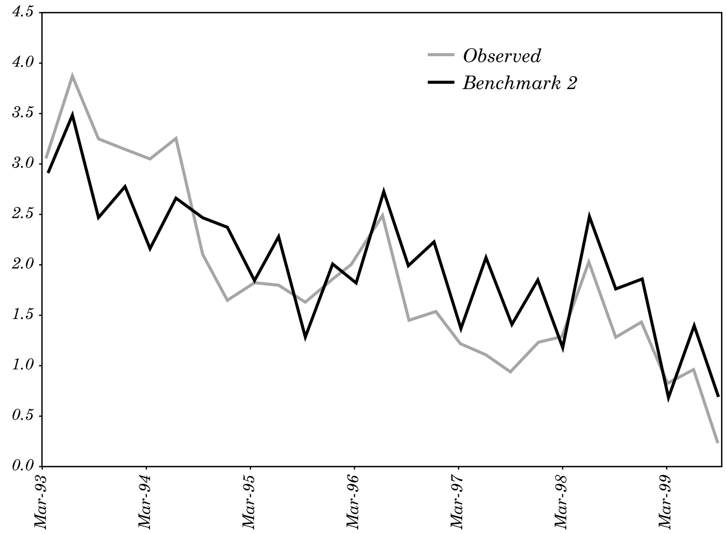
Date	*Actual target*	*Cold-turkey target*	*Gradual target*
December 1991	17.5	17.5	17.5
December 1992	15.0	15.0	15.0
December 1993	11.0	11.0	11.0
December 1994	10.0	8.0	10.5
December 1995	9.0	5.0	10.0
December 1996	6.5	3.0	9.5
December 1997	5.5	3.0	9.0
December 1998	4.5	3.0	8.5
December 1999	4.3	3.0	8.0
December 2000	3.5	3.0	7.5

Source: Central Bank of Chile and authors' assumptions.
a. December-to-December percent change in CPI.

path, termed a gradual target, and a more aggressive path, termed a cold-turkey target. The gradualist strategy considers a target reduction by only half of a percentage point (50 basis points) per year starting in 1994. The cold-turkey stabilization considers a quicker target reduction to attain a stationary inflation level of 3 percent in 1996 and beyond (see table 12).

Figure 12. Core Inflation: Observed and Benchmark 2

Quarterly rate of change, in percent



Source: Authors' calculations.

When altering the targets, the policy interest rate has to be changed accordingly. The structural model presented above is therefore extended to include the following policy reaction function for the Central Bank:[24]

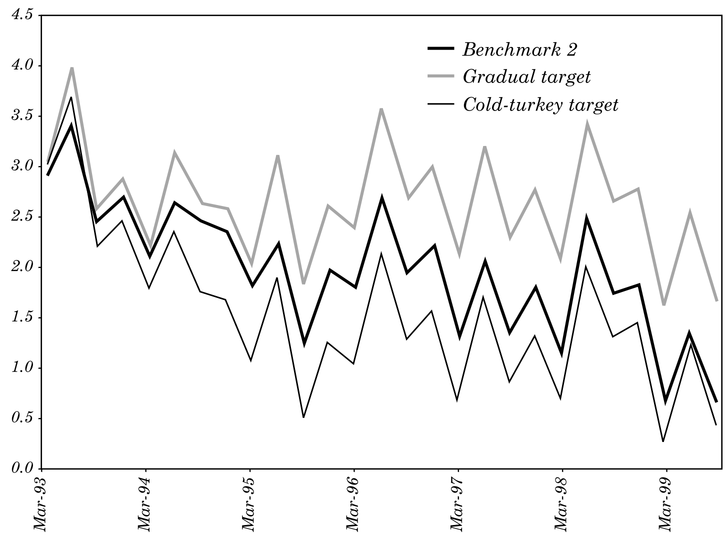
$$PRBC_t = (1-\rho)\times\left[\psi_0 + \psi_1\left(\pi 4^S_{t+3} - TAR4_{t+3}\right) + \psi_2 CAD_{t+2}\right] + \rho PRBC_{t-1} + \psi_3 D983. \quad (12)$$

This policy reaction function is consistent with Corbo (2002), which extends previous work by Taylor (1993) and Clarida, Galí, and Gertler (1998) for countries that follow a policy aimed at achieving a gradual reduction in inflation. In this equation, the policy interest rate is specified as a function of the gap between expected inflation and target inflation, the gap between the ratio of the current account deficit to GDP

24. In this equation, $\pi 4^S_t$ is the four-quarter cumulative sum of quarterly core inflation rates, $TAR4_t$ is the four-quarter cumulative sum of quarterly target inflation rates, and D983 is a dummy variable (equal to 1 in the third quarter of 1998).

Figure 13. Core Inflation: Benchmark 2, Gradual Target, and Cold-Turkey Target Simulation

Quarterly rate of change, in percent



Source: Authors' calculations.

and a target ratio (which is set at 4.5 percent of GDP), and the lagged value of the policy rate.[25]

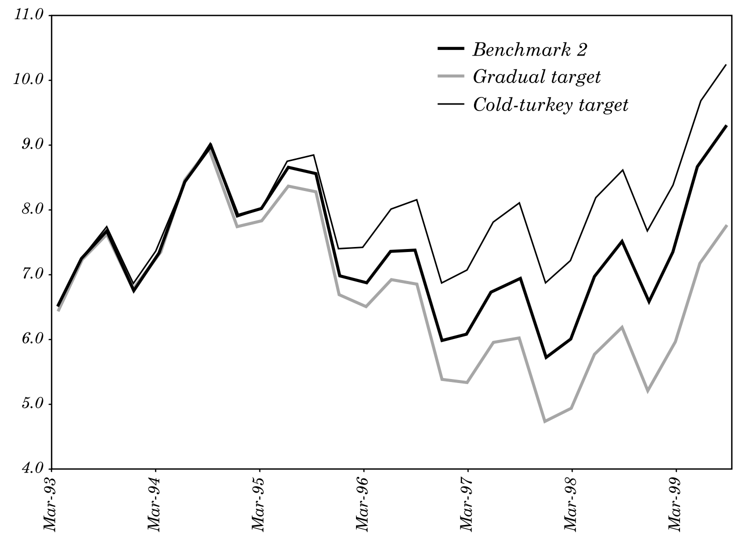
The amended model, which now includes the policy reaction function, is run to provide a new set of benchmark results for core inflation (benchmark 2). These are compared to actual core inflation in figure 12. The simulated benchmark 2 levels are closer to the actual values than was the case with benchmark 1. By endogenizing the policy interest rate, the latter is adjusted when the inflation forecast differs from the target level, helping to bring actual inflation closer to the target.

The counter-factual simulation results for core inflation under the gradualist strategy, the cold-turkey approach, and the benchmark 2 case are reported in figure 13. Unsurprisingly core inflation under the gradualist (cold-turkey) approach is well above (below) benchmark 2

25. The variables on the right-hand side of this equation are potentially endogenous. We therefore reestimate this equation using generalized method of moments (GMM) to obtain consistent and efficient coefficient estimates, reported in table 10.

Figure 14. Unemployment: Benchmark 2, Gradual Target, and Cold-Turkey Target Simulation

Quarterly rate, in percent



Source: Authors' calculations.

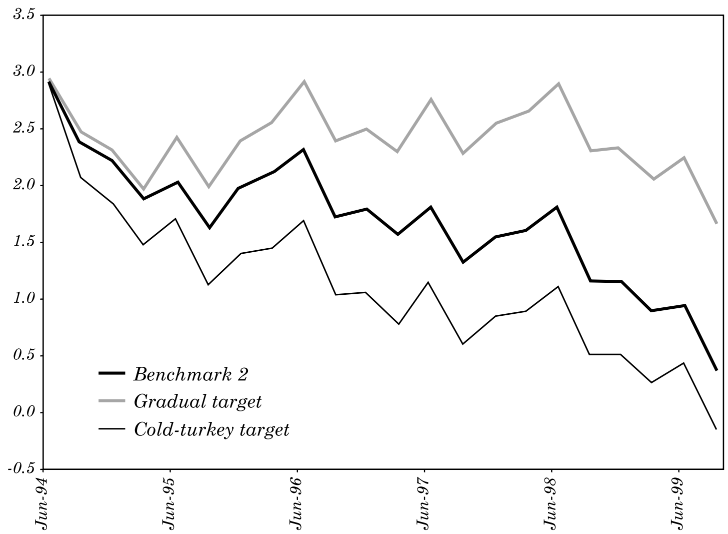
values. In the case of the cold-turkey target, the convergence of the simulated values toward target values is initially slow; this confirms that inflation exhibits substantial inertia and that the selection of a hard target could have resulted in higher unemployment and only a small gain in terms of lower inflation.

Figure 14 depicts the unemployment paths for both counter-factual strategies and the benchmark 2 case. The gradual (cold-turkey) strategy results in lower (higher) unemployment—a result of slow (quick) adjustment of inflation expectations toward target levels. To throw further light on the cost of disinflation, we also compute the sacrifice ratio for the reduction of inflation, comparing the cumulative sum of unemployment increases to the cumulative sum of the gains in inflation reduction. The sacrifice ratio corresponding to the cold-turkey approach is –1.26. Under a gradualist strategy, the sacrifice ratio is only –0.95. Alternative disinflation speeds thus entail asymmetric employment and output costs.

To check the robustness of our results, we use an alternative measure of inflation expectations, instead of the difference between nominal and

Figure 15. Core Inflation: Benchmark 2, Gradual Target, and Cold-Turkey Target Simulation Using Consensus Forecast Expectations

Quarterly rate of change, in percent



Source: Authors' calculations.

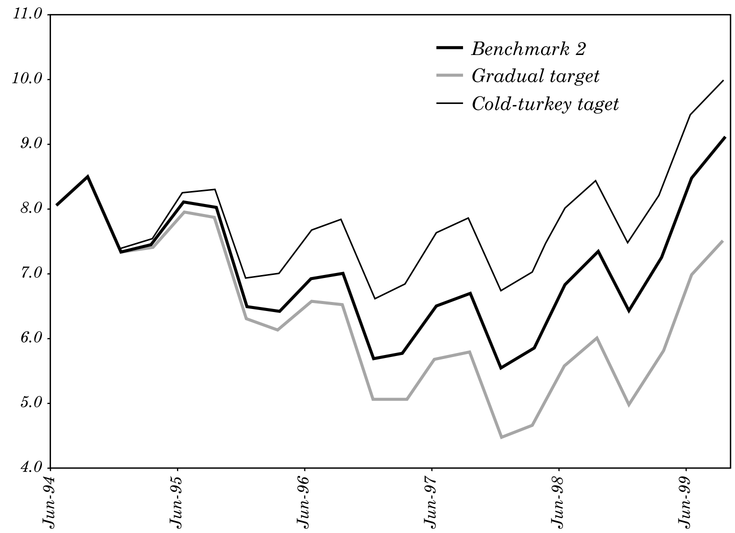
real interest rates. We reestimate equations 4, 5, and 10 using the Consensus Forecast measure of inflation expectations for Chile.[26] We then run the benchmark and the two counter-factual simulations again. The results, reported in figures 15 and 16, are fairly similar to those shown in figures 13 and 14. The sacrifice ratios are –1.26 for the cold-turkey strategy and –0.99 for the gradualist approach. This confirms the robustness of our results to alternative measures for inflation expectations.

Finally it could be claimed that our comparison between cold-turkey and gradualist strategies to disinflation does not properly represent the cold-turkey case because inflation expectations do not immediately adjust to target levels.[27] That is, inflation expectations do not embody full credibility of the inflation target because they are still determined by equation 10. To take into account a fully credible cold-turkey

26. We thank Consensus Economics for providing this data.
27. We thank Alejandro Werner for suggesting this exercise.

Figure 16. Unemployment: Benchmark 2, Gradual Target, and Cold-Turkey Target Simulation Using Consensus Forecast Expectations

Quarterly rate, in percent



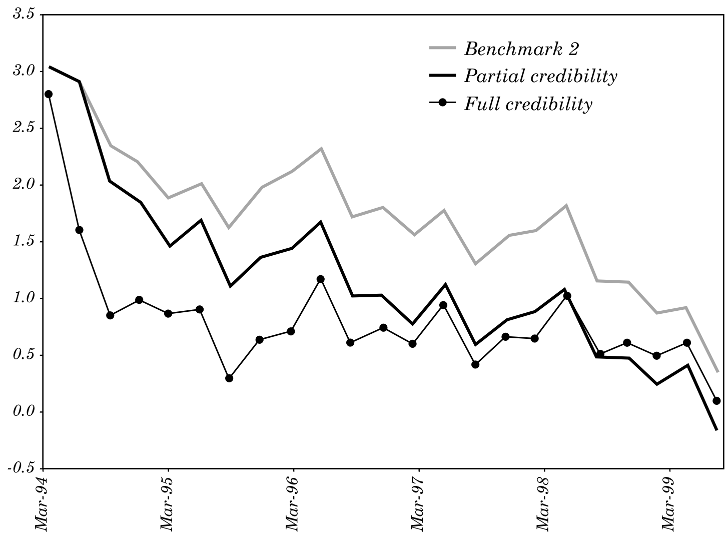
Source: Authors' calculations.

approach (using the Consensus Forecast measure of inflation expectations), we impose the restrictions $\mu_0 = \mu_2 = \mu_3 = 0$ and $\mu_1 = 1$ on equation 10. The simulation results for this amended model, based on the restricted version of equation 10 and run only for the cold-turkey case, are reported in figures 17 and 18. The reduction of inflation would have been somewhat quicker under full credibility than under partial credibility, while the unemployment cost is not too different under the two cases. The sacrifice ratio for full credibility is –0.53, as opposed to –1.26 under partial credibility; this is even lower than the – 0.99 observed in the case of the gradualist approach under partial credibility. We therefore conclude that the actual sacrifice ratio of the cold-turkey approach is bounded between –1.26 and – 0.53.[28]

28. In the price and wage equations, the actual values of the coefficients also depend on the degree of credibility of the inflation target. Therefore, with full credibility the coefficients of expected inflation in both equations could be higher, resulting in an even lower sacrifice ratio.

Figure 17. Core Inflation: Benchmark 2 and Cold-Turkey Target Simulation Using Consensus Forecast Expectations with Partial and Full Credibility

Quarterly rate of change, in percent



Source: Authors' calculations.

7. Conclusions

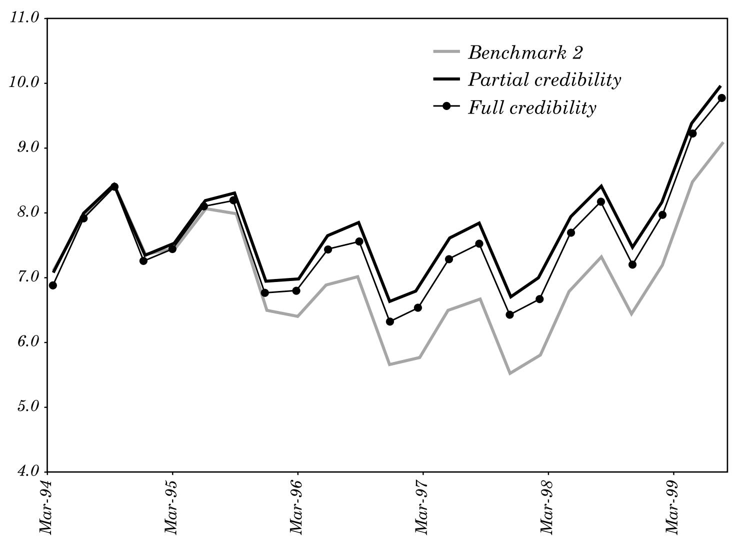
This paper has conducted a wide empirical search on the rationale and consequences of adopting inflation targeting. By comparing policies and outcomes in full-fledged inflation-targeting countries to two control groups of potential inflation targeters and nontargeters, we have identified how inflation targeting makes a difference.

Inflation targeters have been very successful in meeting their targets. In the 1990s, output sacrifice ratios measured by industrial production were lower among inflation targeters after they adopted inflation targeting than among potential inflation targeters and nontargeters. The volatility of industrial output fell in most inflation targeters after adoption to levels similar to those found among Nontargeters.

Inflation targeters have consistently reduced inflation forecast errors (based on country VAR models) toward the low levels prevalent in nontargeting industrial countries.

Figure 18. Unemployment: Benchmark 2 and Cold-Turkey Target Simulation Using Consensus Forecast Expectations with Partial and Full Credibility

Quarterly rate, in percent



Source: Authors' calculations.

Variance decomposition results from VARs show that the influence of price and output shocks on the behavior of inflation and output gaps changed much more strongly among inflation targeters than in nontargeting industrial countries in the course of the 1990s. Inflation persistence declined strongly among inflation targeters during the decade. This suggests that inflation targeting played a role in strengthening the effect of forward-looking expectations on inflation, thereby weakening the weight of past inflation inertia. The influence of inflation shocks on output declined in the 1990s, while output persistence increased significantly during the 1990s. The influence of price and output shocks on inflation and output gaps tended to converge among inflation targeters in the late 1990s to the pattern observed among nontargeting industrial countries. With regard to exchange rate innovations on inflation—evidence of reduced-form devaluation-inflation pass-throughs—no differences were identified between stationary industrialized inflation targeters and nontargeting industrial countries.

Cecchetti and Ehrmann find that central bankers' aversion to inflation does not differ, on average, between inflation targeters and nontargeters. They also find that inflation aversion increased significantly in most inflation targeters when they adopted inflation targeting (that is, during the 1990s), in comparison with nontargeters. We extended Cecchetti and Ehrmann's estimates and inflation-aversion measures in various ways and confirmed their first result: inflation aversion is not different, on average, among inflation targeters in comparison with nontargeters. However, we do not find evidence that stationary industrialized inflation targeters showed increasing inflation aversion in the 1990s. In contrast, inflation aversion increased in the emerging-country transition inflation targeters: Chile and Israel. Furthermore, we find a trend increase in inflation aversion among nontargeting industrial countries. Among potential inflation targeters, inflation aversion fell during the decade.

Does inflation targeting change central bankers' behavior in setting interest rates? We performed variance decomposition exercises from country VARs to test for changes in the response of interest rates to inflation and output innovations. The reaction of interest rates to both inflation and output shocks declined significantly among inflation targeters throughout the 1990s. Among nontargeting industrial countries, however, these reductions were either nil or much weaker in the 1990s. We then estimated Phillips curves that confirmed the latter result: the coefficients of inflation and output gaps have monotonically declined in both emerging and industrial inflation targeters during the 1990s, in comparison with unchanged parameters among nontargeters. This result suggests that inflation targeters gradually gained credibility, which allowed them to achieve their inflation targets with smaller changes in interest rates in the late 1990s than were necessary in the early 1990s.

Chile is the developing country with the longest inflation targeting experience, and inflation has already converged to the Central Bank's long-term target level. Three main lessons emerge from the Chilean experience. First, the initial progress in reducing inflation toward the target was slow as the public was learning about the Central Bank's true commitment to attaining the target. Second, the gradual phasing in of inflation targeting contributed to declining inflation by lowering inflation expectations and changing wage and price dynamics. Third, with respect to the speed of inflation reduction, a cold-turkey approach would have resulted in a larger sacrifice ratio stemming from higher unemployment during the early years of inflation targeting, when credibility was gradually being built up.

APPENDIX

Data Definitions and Sources

Inflation Targeting Periods

Countries are considered as inflation targeters in the following periods: Australia since the fourth quarter of 1994, Canada since the first quarter of 1991, Chile since the fourth quarter of 1990, Finland from the first quarter of 1993 to the fourth quarter of 1999, Israel since the first quarter of 1991, New Zealand since the second quarter of 1990, Spain from the third quarter of 1996 to the fourth quarter of 1998, Sweden since the first quarter of 1993, and the United Kingdom since the fourth quarter of 1992,

Industrial Production

For all countries except those indicated below, we use the seasonally adjusted industrial production index, code 66.czf of the International Financial Statistics (IFS) published by the International Monetary Fund (IMF). For Chile, Colombia, and Mexico, we use the manufacturing production index, IFS code 66ey.czf; for New Zealand, the seasonally adjusted manufacturing production index, IFS code 66ey.czf; for Switzerland, the seasonally adjusted industrial production index (90 = 100), IFS code 66.izf; and for Turkey, the industrial production index, IFS code 66.zf.

Money

For all countries except those indicated below, this variable is defined as the sum of money, IFS code 34.zf, and quasi-money, IFS code 35.zf. For Finland, Germany, Italy, and Spain, it is the sum of currency in circulation, IFS code 34a.nzf, and demand deposits, IFS code 34b.nzf.

Inflation

For all counties, inflation is defined as the rate of change of the consumer price index, IFS code 60.zf.

Interest Rate

For Austria, the interest rate variable is the new issue rate on three-month Treasury bills, IFS code 60 c.zf; for Canada, the overnight money market rate, IFS code 60 b.zf; for Colombia, the lending rate, IFS code 60 b.zf; for Chile, the monthly average rate of ninety-day deposit certificates, obtained from Central Bank of Chile; for Denmark, Norway, Spain, and Sweden, the call money rate, IFS code 60 b.zf; for Finland, the average bank lending rate, IFS code 60 p.zf; for Israel, the overall cost of unindexed credit, IFS code 60 p.zf; for Italy, Japan, Korea, and Switzerland, the money market rate, IFS codes 60 b.zf and 60 p.zf; for Mexico, the Treasury bill rate, IFS code 60 b.zf; for New Zealand, the Comm. bill rate (ninety-day maximum), IFS code 60 b.zf; for the United Kingdom, the overnight interbank rate, IFS code 60 b.zf; for the United States, the federal funds rate, IFS code 60 b.zf; and for Turkey, the interbank money market rate, IFS code 60 b.zf;

Nominal Exchange Rate

For all countries except those indicated below, the nominal exchange rate is defined as the market rate, IFS code ..rf..zf. For Chile and Mexico, it is the principal rate, IFS code ..rf..zf; and for Finland, Norway, Sweden, and Switzerland, it is the official rate, IFS code ..rf..zf,

Relative Trend Deviations

For any variable x, we construct its relative trend deviation as $\log(x) - \log(hpx)$, where log is the natural logarithm and hpx is a trend estimated by the Hodrick-Prescott filter of x. This measure represents the relative distance of the variable with respect to its trend, rather than the period change of the variable.

REFERENCES

Agénor, P. R. 2002. "Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting." In this volume.

Bernanke, B. S., and others. 1999. *Inflation Targeting: Lessons from the International Experience*. Princeton University Press.

Cecchetti, S. G., and M. Ehrmann. 2002. "Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers Preferences and Outcomes." In *Monetary Policy: Rules and Transmission Mechanisms,* edited by N. Loayza and K. Schmidt-Hebbel. Santiago: Central Bank of Chile.

Clarida, R., J. Galí, and M. Gertler. 1998. "Monetary Policy Rules in Practice: Some International Evidence." *European Economic Review* 42(6): 1033–67.

Corbo, V. 1998. "Reaching One-Digit Inflation: The Chilean Experience." *Journal of Applied Economic*s 1(1): 123–63.

————. 2002. "Monetary Policy in Latin America in the 90s." In *Monetary Policy: Rules and Transmission Mechanisms,* edited by N. Loayza and K. Schmidt-Hebbel. Santiago: Central Bank of Chile.

Corbo, V., and K. Schmidt-Hebbel. 2000. "Inflation Targeting in Latin America." Paper presented at the Latin American Conference on Fiscal and Financial Reforms. Stanford University, November 2000.

Haldane, A. 1999. *Targeting Inflation*. London: Bank of England.

Kuttner, K. N., and A. S. Posen. 1999. "Does Talk Matter after All? Inflation Targeting and Central Bank Behavior." Staff Report 88. Federal Reserve Bank of New York.

Leiderman, L., and L. E. O. Svensson. 1995. *Inflation Targeting*. London: Centre for Economic Policy Research.

Meyer, L. H. 2001. "Inflation Targets and Inflation Targeting." Paper presented at the University of California at San Diego Economics Roundtable. San Diego, California, 17 July.

Mishkin, F. S. 2000. "Inflation Targeting in Emerging Market Countries." *American Economic Review* 90(2): 105–09.

Mishkin, F. S., and A. Posen. 1997. "Inflation Targeting: Lessons from four Countries." Federal Reserve Bank of New York *Economic Policy Review* 3: 9-110.

Mishkin, F. S., and M. A. Savastano. 2000. "Monetary Policy Strategies for Latin America." Working Paper 7617. Cambridge, Mass.: National Bureau of Economic Research.

Mishkin, F. S., and K. Schmidt-Hebbel. 2002. “A Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know?”. In this volume.

Restrepo, J. 1998. “Reglas monetarias en Colombia y Chile.” *Coyuntura Económica* 28(4): 132–54.

Schaechter, A., M. R. Stone, and M. Zelmer. 2000. “Practical Issues in the Adoption of Inflation Targeting by Emerging Market Countries.” Occasional Paper 202. Washington: International Monetary Fund (IMF).

Taylor, J. B. 1993. “Discretion versus Policy Rules in Practice.” *Carnegie-Rochester Conference Series on Public Policy* 39 (December): 195–214.

————. 2000. *Monetary Policy Rules*. University of Chicago Press.