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Does Inflation Targeting Make a Difference?

Frederic S. Mishkin and Klaus Schmidt-Hebbel [*]

Abstract

Yes, as inferred from panel evidence for inflation-targeting countries and a control group of high-achieving industrial countries that do not target inflation. Our evidence suggests that inflation targeting helps countries achieve lower inflation in the long run, have a smaller inflation response to oil-price and exchange-rate shocks, strengthen monetary policy independence, improve monetary policy efficiency, and obtain inflation outcomes closer to target levels. Some benefits of inflation targeting are larger when inflation targeters have achieved disinflation and are able to make their inflation targets stationary. Despite these favorable results for inflation targeting, our evidence generally does not suggest that countries that adopt inflation targeting have attained better monetary policy performance relative to our control group of highly successful non-inflation targeters. However, inflation targeting does seem to help all country groups to move toward the performance of the control group. The performance attained by industrial-country inflation targeters generally dominates the performance of emerging-economy inflation targeters and is similar to that of industrial non-inflation targeting countries.

JEL Codes: E52, E58.
Keywords: Inflation targeting, monetary policy.

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Nontechnical Summary

Inferring from panel data, we found empirical evidence that inflation targeting helps countries achieve lower inflation in the long run, exhibit a smaller inflation response to oil-price and exchange-rate shocks, strengthen monetary policy independence, improve monetary policy efficiency, and obtain inflation outcomes closer to target levels. Some of the latter benefits are larger when inflation targeters achieve stationary targets. However, our evidence generally does not suggest that countries that adopt inflation targeting have attained better monetary policy performance relative to our control group of highly successful non-inflation targeters. But inflation targeting does seem to help all country groups to move toward the performance of the world's best performers.

Introduction

Since New Zealand adopted inflation targeting in 1990, a steadily growing number of industrial and emerging economies have explicitly adopted an inflation target as their nominal anchor. Eight industrial countries and thirteen emerging economies had full-fledged inflation targeting in place in early 2005. Many other emerging economies are planning to adopt inflation targeting in the near future. This trend has triggered an intensifying debate over whether inflation targeting makes a difference. Opinions diverge widely over whether central banks are better off after they adopt inflation (forecast) targeting as an explicit and exclusive anchor for conducting monetary policy. Analysts are demanding hard evidence that inflation targeting improves macroeconomic performance relative to countries without explicit inflation targeting.

Empirical evidence on the direct link between inflation targeting and particular measures of economic performance generally provides some support for the view that inflation targeting is associated with an improvement in overall economic performance.[1] This conclusion is derived from the following four results:[2]

—Inflation levels, inflation volatility, and interest rates have declined after countries adopted inflation targeting.

—Output volatility has not worsened after the adoption of inflation targeting; if anything, it has improved.

—Exchange rate pass-through seems to be attenuated by the adoption of inflation targeting.

—The fall in inflation levels and volatility, interest rates, and output volatility is part of a worldwide trend in the 1990s, and inflation targeters have not done better in terms of these variables or in terms of exchange rate pass-through than nontargeting industrialized countries such as Germany or the United States.

Although these results suggest that inflation targeting is beneficial, they are less conclusive than first appears. Ball and Sheridan (2005), in one of the few empirical papers critical of inflation targeting, argue that inflation targeting does not make a difference in industrial countries. They claim that the apparent success of inflation targeting countries simply reflects regression toward the mean: that is, inflation will fall faster in countries that start with high inflation than in countries with an initially low inflation rate. Since the countries that adopted inflation targeting generally had higher initial inflation rates, their larger decline in inflation merely reflects a general

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1) Roger and Stone (2005) reach this conclusion.

2) For evidence supporting these first four results, see Bernanke and others (1999), Corbo, Landerretche, and Schmidt-Hebbel (2002), Neumann and von Hagen (2002), Hu (2003), Truman (2003), and Ball and Sheridan (2005). There is also some mildly favorable evidence on the impact of inflation targeting on sacrifice ratios. Bernanke and others (1999) do not find that sacrifice ratios in industrialized countries fell with the adoption of inflation targeting, while Corbo, Landerretche, and Schmidt-Hebbel (2002) conclude, based on a larger sample of inflation targeters, that inflation targeting did lead to an improvement in sacrifice ratios. Cohen, Gonzalez, and Powell (2003) also find that inflation targeting leads to nominal exchange rate movements that are more responsive to real shocks than nominal shocks. This might indicate that inflation targeting can help the nominal exchange rate act as a shock absorber for the real economy.

tendency of all countries, both targeters and nontargeters, to achieve better inflation and output performance in the 1990s, when inflation targeting was adopted.

Ball and Sheridan's findings are heavily disputed by Hyvonen (2004), Vega and Winkelried (2005), IMF (2005), and Batini and Laxton (forthcoming), who provide evidence—based on using samples that include emerging countries and different specifications and estimation techniques—that inflation levels, persistence, and volatility are lower in inflation-targeting countries than in nontargeters. However, Ball and Sheridan's paper does raise a serious issue about the empirical literature on inflation targeting. The adoption of inflation targeting is clearly an endogenous choice, as is pointed out by Mishkin and Schmidt-Hebbel (2002) and Gertler (2005). The finding that better performance is associated with inflation targeting thus may not imply that inflation targeting causes this better performance.

The fourth result above—namely, that the inflation and output performance of inflation-targeting countries improves but does not surpass countries like Germany and the United States—also suggests that what really matters for successful monetary policy is establishing a strong nominal anchor. While inflation targeting is one way to achieve this, it is not the only way. Germany was able to create a strong nominal anchor with its monetary targeting procedure (see Bernanke and Mishkin, 1992; Mishkin and Posen, 1997; Bernanke and others, 1999; Neumann and von Hagen, 2002). In the United States, the strong nominal anchor has been Alan Greenspan (see, for example, Mishkin, 2000). It is not at all clear that inflation targeting would have improved performance during the Greenspan era, although it might well do so in the future if the United States is not as fortunate with choices of Fed chairmen like Greenspan and Bernanke (Mishkin, 2005). Furthermore, as emphasized in Calvo and Mishkin (2003) and Sims (2005), an inflation target alone is not capable of establishing a strong nominal anchor if the government pursues irresponsible fiscal policy or inadequate prudential supervision of the financial system, which might then be prone to a financial crisis.

Empirical evidence that focuses on whether inflation targeting strengthens the nominal anchor may be even more telling about the possible benefits of inflation targeting. Recent research has found the following additional results:

— Evidence that the adoption of inflation targeting leads to an immediate fall in inflation expectations is not strong.[3]

— Inflation persistence, however, is lower for countries that have adopted inflation targeting than for countries that have not.

— Inflation expectations appear to be more anchored for inflation targeters than nontargeters: that is, inflation expectations react less to shocks to actual inflation for targeters than nontargeters, particularly at longer horizons.[4]

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[3] For example, Bernanke and others (1999) and Levin, Natalucci, and Piger (2004) do not find that inflation targeting leads to an immediate fall in expected inflation, but Johnson (2002, 2003) finds some evidence that expected inflation falls after the announcement of inflation targets.

[4] Gürkaynak, Levin, and Swanson (forthcoming); Levin, Natalucci, and Piger (2004); Castelnuovo, Nicoletti-Altimari, and Palenzuela (2003).

These results suggest that once inflation targeting has been in place for a while, it does make a difference by anchoring inflation expectations and thus strengthening the nominal anchor. Inflation targeting could therefore strengthen the nominal anchor in the United States even beyond what was achieved under "maestro" Greenspan. Recent theory on optimal monetary policy, sometimes called the new neoclassical synthesis (Woodford, 2003; Goodfriend and King, 1997), shows that establishing a strong nominal anchor is a crucial element in successful monetary policy. Consequently, the evidence on anchoring inflation expectations bolsters the case for the adoption of inflation targeting.

Our survey of the debate on whether inflation targeting matters indicates that open questions remain, particularly with regard to other dimensions of comparative macroeconomic performance in inflation-targeting countries, both over time and in comparison with nontargeting countries. Are the inflation level and the volatility of inflation and output lower in inflation-targeting countries? Do monetary policy and macroeconomic performance variables respond differently to shocks under inflation-targeting than under other monetary policy regimes? Is monetary policy efficient under inflation-targeting? Are inflation-targeting central banks more accurate in hitting their targets than nontargeters in maintaining or achieving stable inflation?

This paper addresses these questions systematically by applying a common methodological approach, across issues and throughout the paper, based on four methodological choices. First, we look for empirical evidence in a sample of twenty-one industrial and emerging inflation-targeting countries before and after their adoption of inflation targeting, and we compare their performance to a control group of thirteen industrial countries without inflation targeting (termed nontargeters). The macroeconomic and monetary policy performance of the nontargeters in this control group is among the best in the world, raising the odds against finding evidence of better performance among inflation-targeting countries. Second, we distinguish between two types of inflation-targeting regimes, one in which inflation targets are still converging to the long-run goal for inflation and one in which the inflation target is stationary. This distinction is important because the strength of the nominal anchor may vary depending on whether inflation targets are stable. Third, we test for differences in the group behavior of inflation targeters and nontargeters—and for changes between pre- and post-targeting periods among targeters—making statistical inferences from panel data estimations, panel vector autoregressive models, and panel impulse responses. Finally, to exploit the rich available data and identify dynamic patterns, we use a high-frequency sample of quarterly data, covering the 1989–2004 period and subperiods.

Section 1 of the paper describes more closely the two samples of inflation targeters and nontargeters and presents comparative descriptive statistics on their inflation and growth performance. The following sections test for differences in performance between targeters and nontargeters and (for targeters) between pre- and post-targeting periods, along four dimensions. Section 2 revisits the question about differences in inflation behavior among country groups, extending previous research on the same issue to a country panel and considering alternative estimation methods and control groups. Section 3 tests for differences in the country groups' dynamic response of inflation to oil price and exchange rate shocks and of domestic interest rates to international interest rate shocks. Section 4 measures differences in macroeconomic performance (output and inflation volatility) and monetary policy efficiency. Section 5 reports differences between country groups in meeting inflation targets or objectives. Section 6 offers concluding remarks.

1. Descriptive Inflation and Output Statistics

Inflation targeting was started by New Zealand in 1990, with several industrial countries and emerging economies following in subsequent years. Our sample of inflation-targeting countries comprises eight industrial countries and thirteen emerging economies that had full-fledged inflation targeting in place in late 2004.[5]

Dating the adoption of inflation targeting is not uncontroversial, particularly in emerging economies that started a version of inflation targeting termed partial inflation targeting. Under partial inflation targeting, countries often maintained an additional nominal anchor (typically an exchange rate band), did not satisfy key preconditions for inflation targeting, and did not put in place formal features of inflation targeting (such as formalizing monetary policy decisions or publishing an inflation report with inflation forecasts). In contrast, under full-fledged inflation targeting, the inflation target is the only nominal anchor (although exchange rate interventions could be present), and the central bank pursues most formal policy and transparency features observed under best-practice inflation targeting.

Here we follow much of the previous literature (for example, Corbo, Landerretche, and Schmidt-Hebbel, 2002; Mishkin and Schmidt-Hebbel, 2002; Roger and Stone, 2005) in dating the adoption of inflation targeting with the start of either partial or full-fledged inflation targeting, in opposition to work that considers inflation targeting as starting only with full-fledged targeting (for example, IMF, 2005; Batini, and Laxton, forthcoming). For the reasons mentioned above, however, we identify two distinct post-adoption periods, based on the stationarity of the inflation target itself. During target convergence, inflation targets are adjusted downward, typically for calendar years, and they are based on annual or multi-annual announcements. During target stationarity, inflation targets are fixed at a constant level or range for an indefinite future, although some countries occasionally make slight adjustments to the target.[6] An important advantage of using converging versus stationary targets to identify relevant post-targeting periods is that this distinction is based on an observable feature that is precisely dated, whereas the partial/full-fledged dichotomy is based on more subjective characteristics and dating.

Table 1 summarizes the information on inflation-targeting countries for the world population of inflation targeters. The data sample used in this paper starts with the first quarter of 1989 and extends through the fourth quarter of 2004. Pre-targeting sample periods range from one year (New Zealand, the most senior inflation targeter) to twelve years (Iceland, Norway, Hungary, and the Philippines, the most recent targeters). Target convergence periods also vary significantly in extension, from no convergence (for example, Australia and Thailand) to eleven years of convergence (Israel). The length of the stationary-target period is also heterogeneous, extending from one year (Poland) to twelve years (New Zealand).

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5) We therefore exclude Finland and Spain, which adopted inflation targeting in 1993 and 1995, respectively, before adopting the euro in 1999.

6) Countries that have exceptionally and only marginally adjusted their stationary target levels or ranges include New Zealand and the United Kingdom.

Table 1: Inflation-Targeting Periods and 2005 Target Levels in Twenty-One Inflation-Targeting Countries

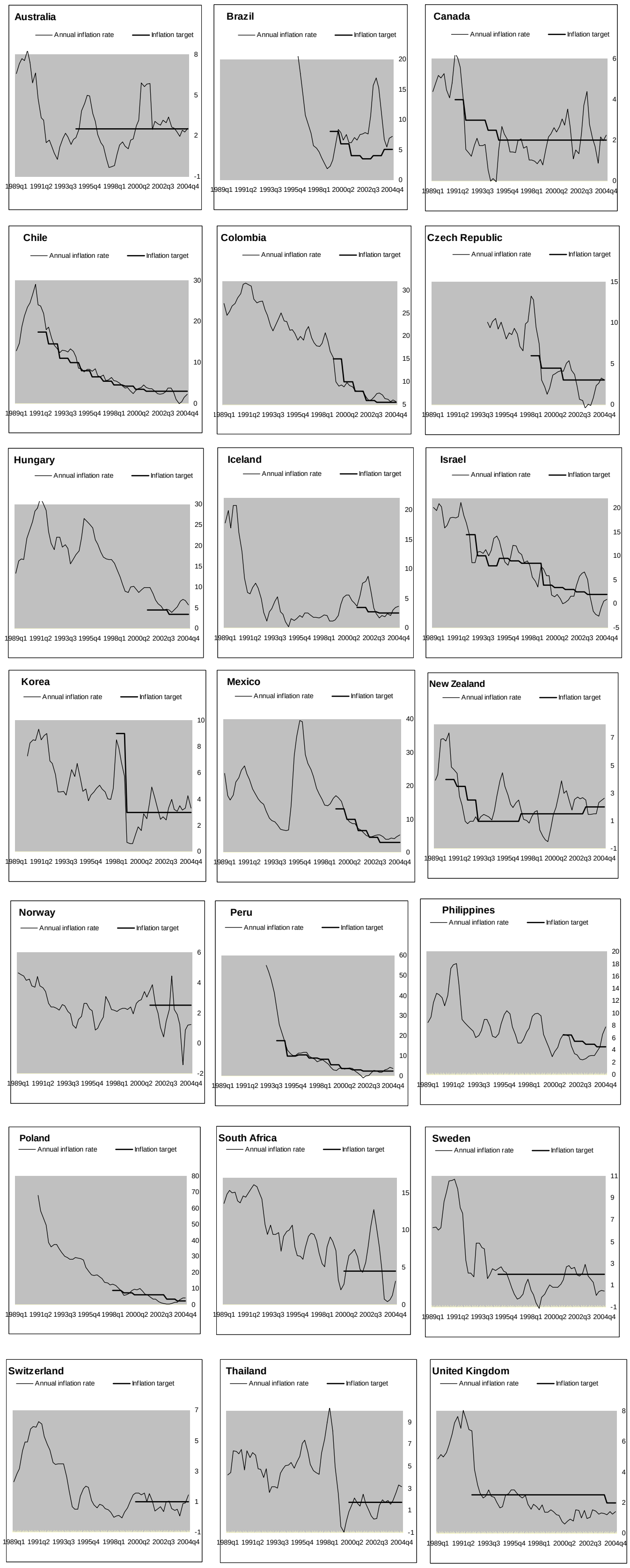
Country	**Pre-targeting period**	**Inflation-targeting period**		**2005 inflation target level (%)**
		Converging-target period	*Stationary-target period*	
Industrial Economies				
Australia	1989:1–1994:2		1994:3–2004:4	2–3
Canada	1989:1–1990:4	1991:1–1994:4	1995:1–2004:4	1–3
Iceland	1989:1–2000:4	2001:1–2002:4	2003:1–2004:4	2.5
New Zealand	1989:1–1989:4	1990:1–1992:4	1993:1–2004:4	1–3
Norway	1989:1–2000:4		2001:1–2004:4	2.5
Sweden	1989:1–1994:4		1995:1–2004:4	2 (+/–1)
Switzerland	1989:1–1999:4		2000:1–2004:4	<2
United Kingdom	1989:1–1991:4		1992:1–2004:4	2
Group average				2.2
Emerging Economies				
Brazil	1989:1–1998:4	1999:1–2004:4		4.5 (+/–2.5)
Chile	1989:1–1990:4	1991:1–2000:4	2001:1–2004:4	2–4
Colombia	1989:1–1998:4	1999:1–2004:4		5 (+/–0.5)
Czech Republic	1989:1–1997:4	1998:1–2004:4		3 (+/–1)
Hungary	1989:1–2000:4	2001:1–2004:4		3.5 (+/–1)
Israel	1989:1–1991:4	1992:1–2002:4	2003:1–2004:4	1–3
Korea	1989:1–1997:4	1998:1–1998:4	1999:1–2004:4	2.5–3.5
Mexico	1989:1–1998:4	1999:1–2002:4	2003:1–2004:4	3 (+/–1)
Peru	1989:1–1993:4	1994:1–2001:4	2002:1–2004:4	2.5 (+/–1)
Philippines	1989:1–2000:4	2001:1–2004:4		5–6
Poland	1989:1–1997:4	1998:1–2003:4	2004:1–2004:4	2.5 (+/–1)
South Africa	1989:1–1999:4		2001:1–2004:4	3–6
Thailand	1989:1–1999:4		2000:1–2004:4	0–3.5
Group average, eight stationary-target countries				3.0
Group average, five converging-target countries				3.6

Source: Authors' calculations, based on data from central bank websites.

Our most recent data on inflation target levels (or midpoints of target ranges) show little country variation. For the eight stationary industrial countries, the average inflation target level was 2.2 percent in 2005. Among emerging economies, the average inflation target level that year was 3.0 percent for the subsample of eight inflation targeters with a stationary target and 3.6 percent for the subsample of inflation targeters that were still converging toward future stationary target levels in 2004.

Figure 1 depicts inflation targets since the adoption of inflation targeting and twelve-month consumer price index (CPI) inflation rates for every inflation targeter, based on quarterly data for 1989–2004. Visual inspection of the absolute differences between inflation and target levels suggests that inflation-targeting countries have been successful in meeting their targets. Section 5 tests this hypothesis more systematically and compares the finding with a control group of nontargeters.

Figure 1: Annual Inflation Rates and Targets in Inflation-Targeting Countries, 1990–2004



***Source**:* authors' calculations, based on data from the IMF's International Financial Statistics and central bank websites.

Our control group of nontargeters comprises a selective set of thirteen industrial countries that are at the international frontier of macroeconomic management and performance: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Portugal, and the United States. In choosing this control group, we reduce the probability of finding evidence of better comparative performance under inflation targeting, considering that the world population of twenty-one inflation targeters encompasses a more heterogeneous country set in terms of past performance, current macroeconomic institutions, and income levels.[7]

Figure 2 shows that inflation targeters and nontargeters had very different annual inflation rates in the late 1980s and early 1990s.[8] However, as time passed and inflation targeting was adopted in the 1990s, the inflation gap between inflation targeters and nontargeters fell almost monotonically and was almost closed by 2004. This inflation convergence is largely due to the massive decline in inflation among inflation-targeting emerging economies (figure 3).

Figure 2: Average Annual CPI Inflation Rates in Inflation Targeters and Nontargeters, 1989–2004[a]

Source: authors' calculations, based on data from the IMF's *International Financial Statistics* (IFS).

a. Annual averages of inflation for twenty-one inflation-targeting countries and thirteen nontargeting countries, identified in the text. Inflation rates are averages of four-quarterly twelve-month CPI inflation rates for the corresponding year.

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7) Ten of the thirteen countries in the control group joined the euro area in 1999 and therefore do not pursue an independent monetary policy for a significant part of our 1989–2004 sample period. While this may be a disadvantage, we think it is of less concern than the problems—and less relevant results—that would arise if our control group was made up of developing countries.

8) The country sample of inflation targeters depicted in figure 2 is held fixed, including all years before the adoption of inflation targeting in each of the twenty-one countries.

Figure 3: Average Annual CPI Inflation Rates in Industrial and Emerging Inflation Targeters, 1989–2004[a]

Source: authors' calculations based on data from the IMF's International Financial Statistics (IFS).

a. Annual averages of inflation rates for nine industrial and twelve emerging inflation-targeting countries, identified in the text. Inflation rates are averages of four-quarterly twelve-month CPI inflation rates for the corresponding year.

Comparative descriptive statistics on inflation performance confirm these facts (table 2). Inflation targeters reduced their average inflation rates from 12.6 percent before the adoption of inflation targeting to 4.4 percent after the adoption. Inflation declined to 6.0 percent in the post-adoption convergence and then to 2.3 percent after attaining stationary targets. Inflation-targeting emerging economies have recorded 6.0 percent inflation since adopting inflation targeting, while the corresponding figure is only 2.2 percent in inflation-targeting industrial countries. The latter figure is very close to the average 2.1 percent inflation recorded among nontargeters since 1997. We observe a similar pattern for inflation volatility (measured by the standard deviation of inflation). While inflation volatility in industrial inflation targeters is twice the level recorded in nontargeters, inflation persistence is slightly lower in industrial targeters than in nontargeters. The next section more systematically tests for significant differences in inflation performance between inflation targeters and nontargeters, controlling for possible endogeneity of the inflation-targeting regime.

Table 2: Descriptive Statistics on Inflation Levels, Volatility, and Persistence of Inflation Targeters and Nontargeters, 1989–2004[a]

Sample group and statistic	**Pre-targeting period[b]**	**Post-targeting period[c]**
Nontargeting countries		
Mean	4.01	2.07
Standard deviation	1.37	0.79
Persistence	0.91	0.83
All inflation-targeting countries		
Mean	12.63	4.37
Standard deviation	3.91	2.63
Persistence	0.83	0.81
Industrial inflation-targeting countries		
Mean	4.73	2.24
Standard deviation	2.16	1.40
Persistence	0.79	0.76
Emerging inflation-targeting countries		
Mean	18.56	5.97
Standard deviation	5.23	3.55
Persistence	0.87	0.85
Converging-target inflation-targeting countries		
Mean	—	6.04
Standard deviation	—	3.11
Persistence	—	0.78
Stationary-target inflation-targeting countries		
Mean	—	2.32
Standard deviation	—	1.29
Persistence	—	0.71

Source: Authors' calculations, based on data from International Monetary Fund, *International Financial Statistics*.

a. Persistence is measured as the estimated coefficient of an AR(1) equation for inflation.

b. For nontargeters, the corresponding period is 1989–96.

c. For nontargeters, the corresponding period is 1997–2004.

Comparative descriptive statistics on the volatility and persistence of output growth and the output gap reflect the following trends (table 3). Emerging inflation targeters—in contrast to industrial inflation targeters—have achieved a significant reduction in output growth volatility and output gap volatility. Nontargeters also achieved a significant reduction in both volatility measures after 1997, to levels that are below those recorded by industrial inflation targeters. However, output persistence, like inflation persistence, is lower in stationary-target inflation targeters than in nontargeters after 1997.

Table 3: Descriptive Statistics on GDP Growth and Output Gap Volatility and Persistence of Targeters and Nontargeters, 1989–2004[a]

Sample group and statistic	Pre-targeting period[b]	Post-targeting period[c]
Nontargeting countries		
Standard deviation of GDP growth	4.01	2.07
Standard deviation of output gap	1.37	0.79
Persistence of GDP growth	0.73	0.74
Persistence of output gap	0.71	0.68
All inflation-targeting countries		
Standard deviation of GDP growth	3.04	2.23
Standard deviation of output gap	1.87	1.36
Persistence of GDP growth	0.75	0.74
Persistence of output gap	0.65	0.75
Industrial inflation-targeting countries		
Standard deviation of GDP growth	2.01	2.15
Standard deviation of output gap	1.36	1.29
Persistence of GDP growth	0.75	0.74
Persistence of output gap	0.69	0.72
Emerging inflation-targeting countries		
Standard deviation of GDP growth	3.81	2.30
Standard deviation of output gap	2.26	1.41
Persistence of GDP growth	0.75	0.76
Persistence of output gap	0.63	0.78
Converging-target inflation-targeting countries		
Standard deviation of GDP growth	—	2.43
Standard deviation of output gap	—	1.50
Persistence of GDP growth	—	0.68
Persistence of output gap	—	0.76
Stationary-target inflation-targeting countries		
Standard deviation of GDP growth	—	1.52
Standard deviation of output gap	—	1.15
Persistence of GDP growth	—	0.55
Persistence of output gap	—	0.61

Source: Authors' calculations, based on data from International Monetary Fund, *International Financial Statistics*.

a. Persistence is measured as the estimated coefficient of an AR(1) equation for inflation.

b. For nontargeters, the corresponding period is 1989–96.

c. For nontargeters, the corresponding period is 1997–2004.

2. Comparative Inflation Performance

Comparing inflation performance in inflation-targeting countries and nontargeting countries has recently received increased attention (Ball and Sheridan, 2005; Vega and Winkelried, 2005; IMF, 2005). All these works are based only on cross-section evidence, but they differ significantly in the choice of control groups of nontargeters and in estimation techniques. Not surprisingly, results also differ significantly, as summarized below. In this section we focus on the comparative performance of inflation levels, extending the previous literature by considering alternative control groups, a panel data set, and alternative estimation techniques.

In line with previous research, we specify inflation as a weighted average of its long-term or underlying mean and its recent past represented by its lagged value, consistent with a standard partial-adjustment specification:

$$\pi_{i,t} = \lambda\pi^*_{i,t} + (1-\lambda)\pi_{i,t-1} + \varepsilon_{i,t}, \tag{1}$$

where π is the observed twelve-month CPI inflation rate, π^* is the unobserved long-term average twelve-month CPI inflation rate, parameter λ is the weight attached to long-term inflation, and ε is a stochastic disturbance term. Consistent with a panel sample, subindexes *i* and *t* denote country units and time periods.

The unobserved long-term inflation rate is allowed to differ between inflation targeters and nontargeters, according to the following specification based on an inflation-targeting-regime dummy variable and controlling for country- and time-specific effects:

$$\pi^*_{i,t} = \beta D_{i,t} + \alpha_i + \delta_t, \tag{2}$$

where D is the inflation-targeting-regime dummy, β is its coefficient, α is a country fixed effect, and δ is a time fixed effect. For inflation-targeting countries, $D_{i,t}$ is set equal to 0 for periods before inflation-targeting adoption and 1 for periods of inflation targeting; for nontargeters, $D_{i,t}$ is equal to 0 for all periods.

Substituting equation 2 into equation 1 yields the following expression:

$$\pi_{i,t} = \lambda\beta D_{i,t} + (1-\lambda)\pi_{i,t-1} + \lambda\alpha_i + \lambda\delta_t + \varepsilon_{i,t}. \tag{3}$$

By subtracting lagged inflation from both sides of equation 3 and taking *t* and *t* – 1 as the periods before and after the inflation-targeting adoption date, we arrive at the following difference-in-difference cross-section specification, which is used by Ball and Sheridan (2005) and IMF (2005) to test for inflation performance differences between inflation targeters and nontargeters:

$$\pi_{i,post} - \pi_{i,pre} = \gamma_1 + \gamma_2 D_i - \gamma_3\pi_{i,pre} + \mu_i, \tag{4}$$

where $\pi_{i,post}$ ($\pi_{i,pre}$) is average observed inflation in the period after (before) the inflation-targeting adoption date; γ_1, γ_2, and γ_3 are reduced-form coefficients; and μ_i is a stochastic disturbance term.

Table 4 summarizes the cross-section results on comparative inflation performance reported by the previous literature. Ball and Sheridan (2005) reject any long-term differences between inflation targeters and nontargeters regarding inflation mean, volatility, and persistence, for a sample of seven industrial inflation targeters and thirteen industrial nontargeters. They attribute inflation performance improvement in inflation-targeting industrial countries over time to reversion to the mean after the low performance of the 1980s, as reflected by their reported significance of lagged inflation ($\pi_{i,pre}$).[9]

9) Hyvonen (2004) disputes this interpretation by reporting strong evidence for inflation divergence among industrial countries in previous decades.

Table 4: Difference in Inflation between Inflation Targeters and Nontargeters in Previous Literature

Study	Sample	Estimation technique	Difference in long-term inflation level	Difference in long -term inflation volatility	Difference in long -term inflation persistence
Ball and Sheridan (2005)	Targeters: 7 industrial economies; nontargeters: 13 industrial economies	Cross-section, OLS	Zero	Zero	Zero
IMF (2005)	Targeters: 13 emerging economies; nontargeters: 22 emerging economies	Cross-section, OLS	4.8%	3.6%	n.a.
Vega and Winkelried (2005)	Targeters: 23 industrial and emerging economies; nontargeters: 86 industrial and emerging economies	Cross-section, propensity score matching	2.6–4.8%	1.5–2.0%	Ambiguous

Source: References cited herein.

IMF (2005) comes to the opposite conclusion using a similar ordinary least squares (OLS) cross-section estimation technique. The treatment and control groups differ radically from those used by Ball and Sheridan, however: the study compares inflation performance in thirteen developing inflation targeters to a control group of twenty-two developing countries. They find that inflation targeting has helped developing inflation targeters reduce annual long-term inflation rates by 4.8 percent and lower long-term inflation volatility by 3.6 percent.

Finally, Vega and Winkelried (2005) use a matching (propensity score) technique applied to cross-country data for a treatment sample of twenty-three industrial and developing inflation targeters and a control group of eighty-six industrial and developing nontargeters. They report that targeters have lower long-term annual inflation rates ranging from 2.6 percent to 4.8 percent and lower long-term inflation volatilities by 1.5 percent to 2.0 percent. The similarity of Vega and Winkelried’s results to those reported in the IMF suggests that sample differences weigh more heavily than differences in estimation techniques in the results reported by the three cited studies.

Next we extend the tests for differences in inflation performance reported by previous studies along three dimensions. We add the time dimension of the data to the cross-country dimension, focusing on a large panel sample of quarterly data for sixteen years and thirty-four countries. We check the robustness of our results by reporting results based on different estimation techniques (OLS and IV estimations). Finally, we report different results by varying the composition of our inflation-targeting treatment group (separating industrial and emerging-market inflation targeters and stationary-target and converging-target inflation targeters) and of our nontargeting control group (considering different combinations of the nontargeting sample and the pre-targeting sample).

To facilitate comparison with previous studies, we start by estimating equation 4, using quarterly data from 1989–2004 for our full sample of twenty-one developing and industrial inflation targeters and thirteen industrial nontargeters.[10] The results suggest that inflation has been 1 percent higher in inflation-targeting countries than in nontargeters, on average, as reflected by the coefficient of the contemporaneous inflation-targeting dummy variable (table 5). Given the estimated coefficient on pre-targeting (pre-1997) inflation in inflation targeters (nontargeters), equal to –0.85, the long-term average difference in inflation between inflation targeters and nontargeters is estimated at 1.2 percent.[11] This finding of 1 percent higher inflation in inflation-targeting countries is estimated conditional on the inclusion of the highly significant pre-targeting (pre-1997) inflation rate. This estimate is much smaller than the unconditional inflation difference between inflation targeters and nontargeters for the inflation-targeting (post-1997) period, equal to 2.3 percent (the difference between 4.37 percent and 2.07 percent reported in table 2).

Table 5: Inflation Difference between Targeters and Nontargeters: Cross-Section OLS Estimation[a]

Explanatory variable	Coefficient
Inflation-targeting dummy	1.007
	(0.093)*
Pre-targeting (pre-1997) inflation	–0.850
	(0.000)***
Constant	1.468
	(0.002)**
R^2	0.973
No. observations	34
No. countries	34

Source: Author's estimations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. *P* values are reported in parentheses.

Our result stands in contrast with the negative inflation differences between inflation targeters and nontargeters found by Vega and Winkelried (for developing and industrial countries) and the IMF (for developing countries only) and the zero differences in Ball and Sheridan (for industrial countries only). This suggests that differences in results are mostly a reflection of inflation-targeting and nontargeting country group composition. Of all the reported studies, our sample composition is the most stringent against finding favorable effects of the inflation-targeting regime, because our inflation targeters comprise the world population of industrial and developing countries, while our control group encompasses only high-achieving industrial nontargeters. Not surprisingly, we find a significantly higher average inflation level in inflation-targeting countries, conditional on their pre-targeting (or pre-1997) inflation levels.

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[10] For inflation targeters, the pre-and post-adoption periods are identified in table 2. For nontargeters, we follow the convention of previous studies in using an arbitrary cut-off date that is consistent with the targeters' average adoption date. In our sample, this date is the fourth quarter of 1996.

[11] This result must be qualified, however, because of the omission of country fixed effects and the possible endogeneity of the inflation-targeting-regime dummy, addressed below.

We now proceed to extend the above cross-country studies by exploiting both the country and time dimensions of our full panel sample, using both OLS and instrumental variables (IV) estimation techniques. We start by focusing on our full treatment sample comprising all inflation targeters, but considering three different data sets with alternative control groups. Control group 1 includes all 1989–2004 observations for our thirteen nontargeting countries and the pre-targeting observations of all subsequent inflation targeters, implying a large panel dataset of 1,942 quarterly observations for the full sample. Control group 2 covers all 1989–2004 observations for our thirteen nontargeting countries but excludes the pre-targeting observations of all subsequent inflation targeters; this implies a smaller panel of 1,420 quarterly observations for the full sample. Finally, control group 3 encompasses all pre-targeting observations of all subsequent inflation targeters and excludes nontargeting countries; this generates a panel of 1,183 observations.

We turn back to equation 3, which is the relevant specification for our panel sample. In contrast to equation 4 and the corresponding results reported in table 5, the regressors now include inflation lagged by one quarter and exclude inflation in the pre-targeting (pre-1997) period. For reference, we start by reporting pooled OLS results with time dummies, with one for each of the three control groups (columns 1, 3, and 5 in table 6). All subsequent results on inflation differences between country groups are conditional on the inclusion of lagged inflation and thus are not directly comparable to the differences in unconditional inflation means reported in table 2.

Table 6: Difference in Inflation between Inflation Targeters and Nontargeters: Panel Sample[a]

	Control group 1		**Control group 2**		**Control group 3**	
	Pooled OLS	*Panel IV*	*Pooled OLS*	*Pooled IV*	*Pooled OLS*	*Panel IV*
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Inflation-targeting dummy	–0.115	–0.457	–0.010	–0.010	–0.338	–0.491
	(0.047)**	(0.000)***	(0.827)	(0.827)	(0.001)***	(0.002)***
Lagged inflation	0.939	0.904	0.908	0.908	0.932	0.901
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Constant	0.596	0.660	0.568	0.160	0.590	1.023
	(0.004)*	(0.002)***	(0.009)***	(0.465)	(0.082)*	(0.003)
No. observations	1942	1942	1420	1420	1183	1183
No. countries	34	34	34	34	21	21

Source: Author's estimations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. Control group 1 includes all nontargeters and pre-targeters; control group 2 includes all nontargeters; control group 3 includes pre-targeters. Control group 2 regressions cannot be estimated using panel data techniques since country fixed effects are perfectly collinear with inflation targeting. Instruments used in control group 1 and 3 are the lagged inflation-targeting dummy and initial inflation; the instrument used in control group 2 is initial inflation. Time dummies are included for every quarter, and *p* values are reported in parentheses.

The results for control group 1 (first column in table 6) show that the impact of the inflation-targeting regime is to reduce inflation by 0.1 percent per year, with a long-term effect (considering the coefficient estimate of lagged inflation) of –1.9 percent. Recall, however, that we include high pre-targeting inflation levels among subsequent inflation targeters in control group 1. Dropping this subsample yields the results reported for control group 2 in column 3, which show no significant inflation difference between inflation targeters and nontargeters. The estimation presented in column 5 reinforces these results: inflation targeters' long-term inflation is a significant 5 percent lower than their pre-targeting long-term inflation level.

These OLS results may be biased because of endogeneity of the inflation-targeting regime to inflation. As shown by our previous research using a cross-section sample of inflation targeters and nontargeters (Mishkin and Schmidt-Hebbel, 2002), the adoption of inflation targeting is determined by country-specific variables, including central bank independence, the fiscal surplus, and initial inflation.

Given the lack of adequate instruments for the inflation-targeting regime variable for our full panel sample, we estimate a parsimonious first-stage specification for the inflation-targeting dummy as a function of its own lag and average pre-targeting (pre-1997) inflation for inflation targeters (nontargeters).[12] The results for various panel samples of inflation targeters and nontargeters show that both variables are useful instruments of the inflation-targeting-regime dummy; we therefore use them in our subsequent IV estimations.[13]

Returning to table 6, we report IV results for the preceding specification of the inflation difference in columns 2, 4, and 6.[14] This exercise confirms the qualitative results of columns 1, 3, and 5. When we use control group 1 (which includes the inflation targeters' pre-targeting observations since 1989), inflation is lower among inflation targeters. The corresponding estimations for control group 2 show that this result vanishes, yielding no significant difference. With control group 3, however, the lower inflation among inflation targeters is magnified.

We find for control groups 1 and 3 that both the contemporaneous and long-term effects of the inflation-targeting dummy on inflation differentials in inflation-targeting countries are larger for the IV estimations than for the OLS estimations (comparing columns 1 and 2 and columns 5 and 6). This suggests that the absolute size of the inflation-targeting dummy coefficient is biased downward in the OLS estimations, because it fails to take into account the endogeneity of inflation targeting to inflation. When we use IV, the estimated effect of inflation targeting is to lower long-run annual inflation by 4.8 percent (compared to control group 1) and by 5 percent (compared to control group 3). However, there is no significant inflation difference between inflation targeters and nontargeters (control group 2).

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12) Some determinants of an inflation-targeting regime (like central bank independence measures) included in the Mishkin and Schmidt-Hebbel cross-section probit estimation for inflation targeting are not available for time series, while other determinants (such as the ratio of fiscal balance to GDP and trade openness measures) were found to be insignificant in our current panel data sample.

13) Results of the first-stage regressions are available on request.

14) We use time dummies in all IV specifications. For control groups 1 and 3, we also use country-specific dummies (fixed effects). We use a within-estimation technique to eliminate the bias that may arise from the correlation between the fixed effects and the regressors owing to the lags of the dependent variable. Finally, we do not use fixed effects for control group 2, since the inflation-targeting dummy would be perfectly correlated with the fixed effects. We therefore apply a standard pooled IV procedure to control for endogeneity in control group 2.

To explore whether these results for our full treatment sample (including all industrial and emerging-market inflation targeters) are robust to considering different subsamples of inflation targeters, we divide the full treatment sample first into industrial and emerging-market inflation targeters and then into converging-target and stationary-target inflation targeters. Tables 7 and 8 report the corresponding results for our three control groups, using only IV panel estimation techniques. As above, we infer that estimated inflation differences between inflation targeters and nontargeters depend largely on which control group is used. However, they also vary significantly with treatment groups—that is, across different subsamples of inflation targeters.

The results for industrial inflation targeters show that inflation is numerically, but not significantly, lower in industrial inflation targeters than in control groups 1 and 3 (results in columns 1 and 5 of table 7). While this result may be surprising, recall that our econometric results are conditional on including the highly significant lagged inflation variable. In contrast, we find weak evidence (significant at the 10 percent level) that inflation in industrial inflation targeters is significantly lower than in nontargeters for control group 2—by 0.06 percent on impact and by 1.1 percent in the long run. Considering its weak significance, this result is similar to Ball and Sheridan’s (2005) finding of no significant inflation difference for industrial countries, based on OLS cross-section results.

Table 7: Difference in Inflation between Inflation Targeters and Nontargeters, Disaggregated by Industrial and Emerging Targeters[a]

	Control group 1 *(Panel IV)*		**Control group 2** *(Pooled IV)*		**Control group 3** *(Panel IV)*	
Explanatory variable	*Industrial Economies (1)*	*Emerging Economies (2)*	*Industrial Economies (3)*	*Emerging Economies (4)*	*Industrial Economies (5)*	*Emerging Economies (6)*
Inflation-targeting dummy	–0.071	–0.806	–0.061	0.103	–0.142	–0.745
	(0.579)	(0.000)***	(0.098)*	(0.118)	(0.490)	(0.002)***
Lagged inflation	0.889	0.892	0.947	0.902	0.878	0.884
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Constant	0.940	0.953	–0.070	0.196	1.497	0.824
	(0.000)***	(0.000)***	(0.652)	(0.404)	(0.002)***	(0.096)***
Summary statistic						
No. observations	1590	1613	1080	1099	831	854
No. countries	34	33	22	25	21	20

Source: Author’s estimations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. Control group 1 includes all nontargeters and pre-targeters; control group 2 includes all nontargeters; control group 3 includes pre-targeters. Control group 2 regressions cannot be estimated using panel data techniques since country fixed effects are perfectly collinear with inflation targeting. Instruments used in control group 1 and 3 are the lagged inflation-targeting dummy and initial inflation; the instrument used in control group 2 is initial inflation. Time dummies are included for every quarter, and p values are reported in parentheses.

Table 8: Difference in Inflation between Inflation Targeters and Nontargeters, Disaggregated by Stationary and Converging Targeters[a]

	Control group 1 *(Panel IV)*		**Control group 2** *(Pooled IV)*		**Control group 3** *(Panel IV)*	
Explanatory variable	*Stationary targeters (1)*	*Converging targeters (2)*	*Stationary targeters (3)*	*Converging targeters (4)*	*Stationary targeters (5)*	*Converging targeters (6)*
Inflation-targeting dummy	–0.197	–0.858	0.020	0.021	–0.148	–0.929
	(0.093)*	(0.000)***	(0.607)	(0.750)	(0.462)	(0.001)***
Lagged inflation	0.905	0.893	0.950	0.909	0.900	0.887
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Constant	–0.085	0.864	–0.097	0.557	0.055	1.122
	(0.698)	(0.002)***	(0.560)	(0.011)**	(0.901)	(0.138)
No. observations	1636	1567	1118	1050	877	808
No. countries	34	34	24	27	21	21

Source: Author's estimations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. Control group 1 includes all nontargeters and pre-targeters; control group 2 includes all nontargeters; control group 3 includes pre-targeters. Control group 2 regressions cannot be estimated using panel data techniques since country fixed effects are perfectly collinear with inflation targeting. Instruments used in control group 1 and 3 are the lagged inflation-targeting dummy and initial inflation; the instrument used in control group 2 is initial inflation. Time dummies are included for every quarter, and *p* values are reported in parentheses.

The results for emerging inflation targeters point to a considerable gain in inflation. Compared with control groups 1 and 3, emerging inflation targeters record a large and significant reduction of inflation (table 7, columns 2 and 6), which is close to 0.8 percent on impact and 7.0 percent in the long term However, when compared with nontargeters only (control group 2 in column 4), emerging inflation targeters do not record inflation gains.

The results for converging-target and stationary-target inflation targeters also confirm that the choice of treatment and control groups is crucial (see table 8). Our general result on control groups is upheld: inflation differences tend to favor inflation targeters only in comparison with control groups 1 and 3. Inflation differences in favor of inflation targeters are found to be highly significant in converging inflation targeters and not significant in stationary targeters.

The evidence on the comparative inflation performance of inflation targeters and nontargeters reported both here and in the previous literature thus shows that the effect of inflation targeting on inflation can go either way. Our findings suggest that the source of these differences lies in the use of heterogeneous control groups. The failure to use panel data techniques in previous studies prevents the separation of control groups across countries and time. By exploiting both the cross-section and time dimensions of our sample, we found that the largest difference in inflation performance between inflation targeters and nontargeters occurs when the treatment group is compared with its own pre-targeting experience. This effect declines when nontargeting experiences are added to the control group, but it is still statistically significant. When the control group is restricted to nontargeting countries, however, we find no systematic, significant difference in inflation between inflation targeters and nontargeters.

Further disaggregation of the treatment group into industrial and emerging inflation targeters, and into converging-target and stationary-target inflation targeters, yields mixed results. They confirm that results are highly dependent on the choice of control groups. They also suggest that emerging and converging-target inflation targeters record the largest gains in inflation reduction. Finally, industrial inflation targeters exhibit a statistically weak reduction in inflation relative to nontargeting industrial countries.

3. Inflation and Policy Response to Shocks

If inflation targeting improves the credibility of monetary policy and the anchoring of inflation expectations, then we would expect that inflation would respond less to oil price shocks under inflation targeting and there would be less of a pass-through effect from exchange rate shocks. As a result of increased credibility and reduced devaluation to inflation pass-through, inflation targeting may also reinforce monetary policy independence (that is, it may weaken the reaction of domestic interest rates to shocks in foreign rates).

We therefore want to assess whether inflation targeters differ from nontargeters—and whether targeters differ pre- and post-targeting—in the response of inflation to shocks in oil prices and the exchange rate and the response of domestic interest rates to innovations in international interest rates. To test for differences, we adopt a comparative analysis of impulse response functions in different country samples, depending on whether a country has inflation targeting in place (in the spirit of the difference-in-differences approach). However, instead of using traditional country vector autoregressive (VAR) models, we use a panel VAR that allows us to use the larger data set on inflation targeters and nontargeters employed in this paper.

Our approach to assessing the impact of inflation targeting on the responses described above is based on the analysis and comparison of aggregated impulse response functions in the following five groups of countries and periods: inflation targeters before the adoption of inflation targets; inflation targeters after the adoption of inflation targeting; inflation targeters after achieving stationary targets; nontargeters before 1997; and nontargeters after 1997. The first group—namely, inflation targeters in the period before they implemented inflation targeting—is characterized by a heterogeneous sample period, since it starts at the beginning of our sample (first quarter of 1989) but ends according to the date of adoption of inflation targeting in each country. The second group presents the opposite situation, in which the sample period is heterogeneous at the beginning but ends at the same period (fourth quarter of 2004). The third group, which is made up of inflation targeters that have achieved stationary targets, is a subsample of the full inflation-targeting group. The results for this subsample might differ from the full sample because the convergence period from the adoption of inflation targeting to a stationary target may not be characterized by high credibility. The full benefits of inflation targeting in achieving a strong nominal anchor might only be obtained after inflation targets become stationary. The fourth and fifth groups both encompass our sample of countries without inflation targeting, but they differ in their sample period.

Once we have estimated the responses to shocks for each group (as described below), we compare those responses between different pairs of groups. Specifically, we are looking for significant differences (that is, statistically different from zero) between the responses before and after the adoption of inflation targeting in inflation targeters (group 1 versus group 2), before the adoption of inflation targeting and after the achievement of a stationary target (group 1 versus group 3), before and after 1997 in nontargeters (group 4 versus group 5), after inflation targeting in inflation targeters and after 1997 in nontargeters (group 2 versus group 5), and after the achievement of a stationary target and after 1997 in nontargeters (group 3 versus group 5). We also split our treatment group sample (inflation targeters) into industrial and emerging economies to check for possible differences in their performance.

We use panel VAR techniques to estimate the impulse response functions for each group described above. This technique combines a traditional VAR approach with panel data. It allows us to exploit our rich information set and gain efficiency in the estimation. This methodology also allows for unobserved country heterogeneity and facilitates the exposition and analysis of aggregate results.[15] To our knowledge, this technique has not been used in studies of inflation targeting.

Following Love and Zicchino (2002), we allow for individual heterogeneity by introducing fixed effects. Since fixed effects are correlated with the regressors due to lags of the dependent variable, we use forward mean differencing (the Helmert procedure) to remove the mean of all the future observations available for each country. This technique supports the use of lagged regressors as instruments and estimates the coefficients by system generalized method of moments (GMM). Finally, we identify the responses to innovations in the system using the Choleski decomposition of the variance-covariance matrix of residuals, and we apply bootstrap methods to construct their confidence intervals. Since we cannot assume independence among our samples, we also use bootstrap methods to construct confidence intervals for differences in impulse response functions instead of simply taking their differences.[16]

Our VAR system contains the following six variables (in this order): international oil price, international interest rate, output gap, inflation, interest rate, and nominal exchange rate. As is usual in any VAR estimation, the most exogenous variables enter first in the VAR. Since the model yields similar impulse response functions using two or more lags, we selected a lag order of two for reasons of parsimony.

We start by discussing the impulse responses of inflation to oil price shocks (figures 4, 5, and 6) and exchange rate shocks (figures 7, 8, and 9), and end with the impulse responses of domestic to international interest rates (figures 10, 11, and 12).[17] Each figure shows the dynamic response of one selected variable to a shock in another variable of the system. For example, the first cell (first row and first column) of figure 4 depicts the dynamic response of domestic inflation to an international oil price shock in inflation-targeting countries before they adopted inflation

[15] For applied studies using panel VAR estimation, see Holtz-Eakin, Newey, and Rosen, 1988; Love and Zicchino, 2002; Miniane and Rogers, 2003.

[16] If we were simply to assume sample independence, the corresponding confidence intervals for differences would be narrower.

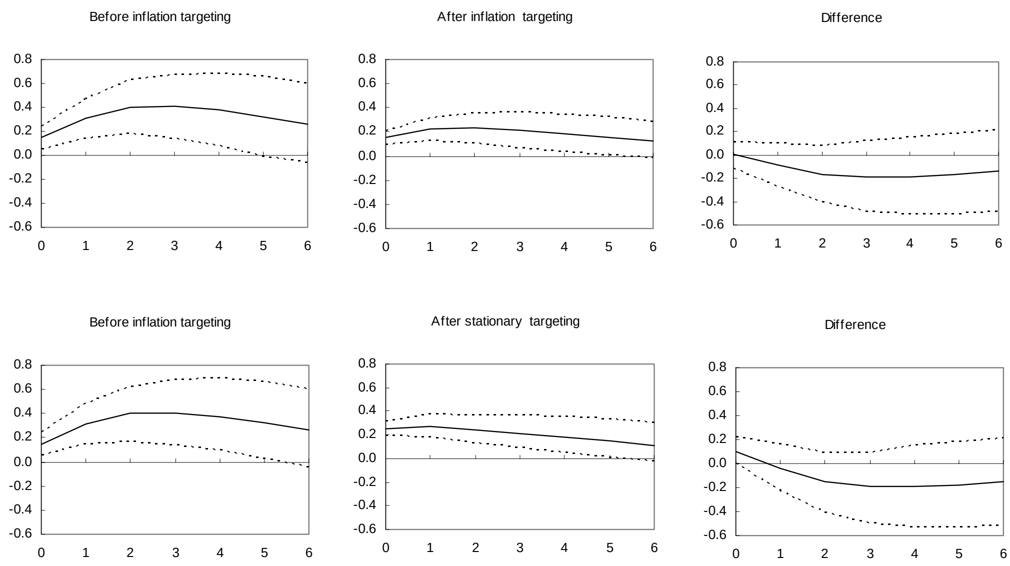
[17] We estimated impulse responses for other shocks (including inflation and output gap responses to interest rate shocks and interest rate responses to exchange-rate shocks) and tested for their differences across country groups, but the results were not relevant.

targeting. The response of domestic inflation to an oil price shock equivalent to one standard deviation is 0.18 percent in quarter 0 (contemporaneous effect) and peaks at 0.40 percent in quarter 2 (after the shock).[18]

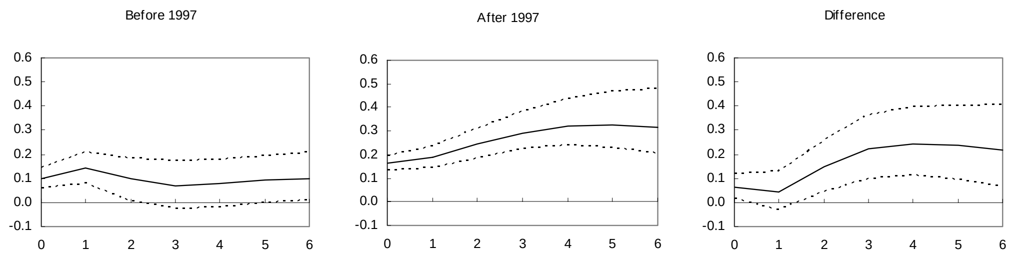
Each row of cells in the figure focuses on a different comparison between the dynamic response of two sample groups. The first three rows report before-and-after comparisons—rows 1 and 2 for inflation targeters before and after they adopted inflation targeting, and row 3 for nontargeters before and after 1997. Rows 4 and 5 report comparisons across country groups: inflation targeters after adopting inflation targeting or after achieving a stationary target, respectively, are compared to nontargeters after 1997. For instance, the first row of figure 4 compares the response of inflation targeters before they adopted inflation targeting (first column) to the response of inflation targeters after they did so (second column). The third column reports the difference between the preceding responses—that is, the response in the second column minus the response in the first column.

Figure 4: Response of Inflation to an Oil Price Shock: All Inflation Targeters

A. Inflation targeters

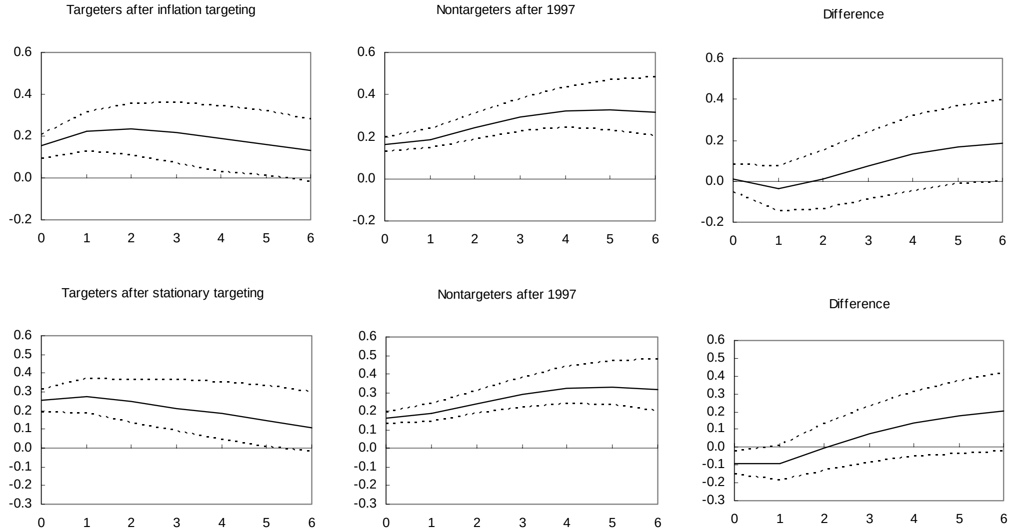


B. Nontargeters



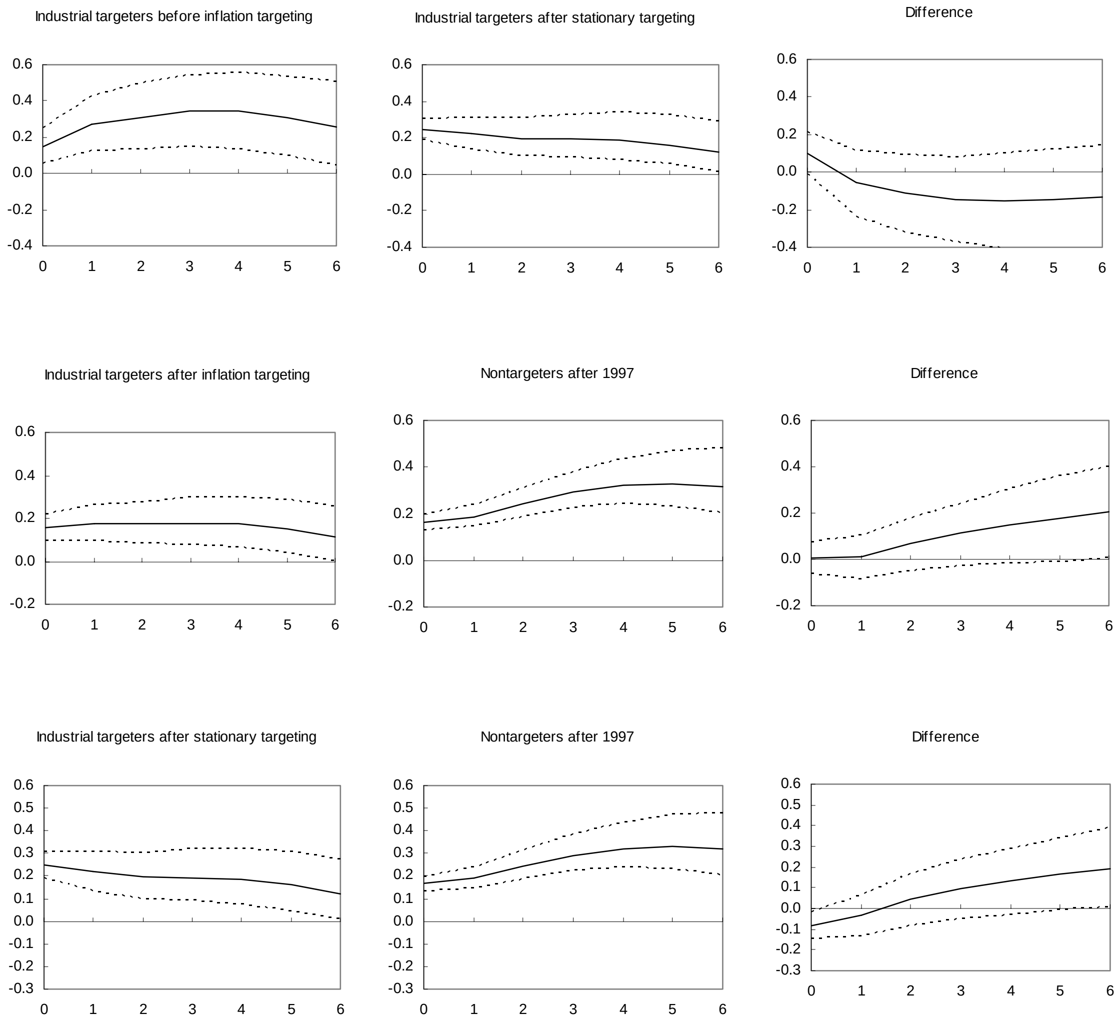
[18)] The three shocks considered in this section—namely, shocks to the international price of oil, the domestic interest rate, and the international interest rate—are measured as one standard deviation of the residual of the corresponding equation.

C. Inflation targeters versus nontargeters



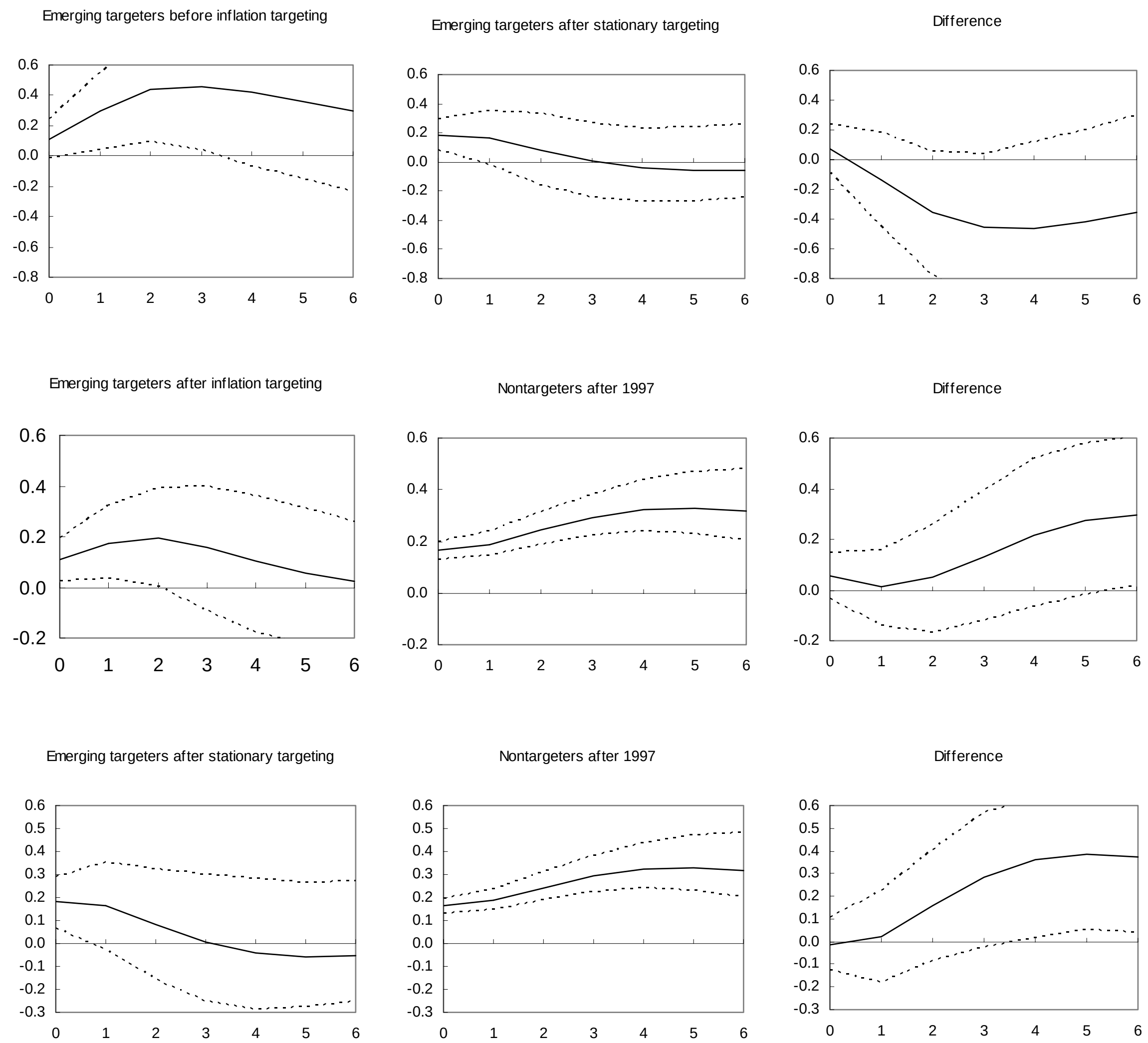
Source: Author's estimations.

Figure 5. Response of Inflation to an Oil Price Shock: Industrial Inflation Targeters



Source: Author's estimations.

Figure 6: Response of Inflation to an Oil Price Shock: Emerging Inflation Targeters



Source: Author's estimations.

The (positive) response of inflation to oil price shocks is smaller in inflation targeters after adopting inflation targeting and after achieving stationarity than before the adoption of inflation targeting (first and second rows of figure 4, respectively). These differences are not statistically different from zero, however, as reflected by the confidence intervals in column three. The opposite result is observed for nontargeters (third row, figure 4). The reaction of inflation to oil prices in nontargeters is larger after 1997 than before 1997, and this difference is statistically different from zero starting in the second quarter after the oil price shock. When we compare all inflation targeters with nontargeters after 1997 (fourth row, figure 4) and stationary inflation targeters with nontargeters after 1997 (fifth row, figure 4), we find that both inflation targeters and stationary inflation targeters react slightly more than nontargeters to oil price shocks on impact and in the first quarter after the shock, but less in the following quarters. While the differences are generally not statistically significant, the short-term response to an oil price shock in inflation-targeting countries is somewhat larger than in nontargeters, but it is smaller from the third quarter onward.

To take into account the sample heterogeneity in our full treatment group of inflation targeters, we divide the group first into industrial and emerging-market inflation targeters and then further into inflation targeters before the start of inflation targeting and stationary-target inflation targeters. Figures 5 and 6 depict the response of inflation to a shock in oil prices, separately for industrial and emerging inflation targeters. The first row of each figure reports the comparison of inflation targeters before they adopted inflation targeting and after they achieved a stationary target; this is equivalent to the before-and-after comparison reported for all inflation targeters in the second row of figure 4. In rows 2 and 3 of each figure, we report comparisons across country groups (inflation targeters after they adopted inflation targeting and nontargeters in row 2 and inflation targeters after they achieved a stationary target and nontargeters in row 3); this is equivalent to the comparisons reported for all inflation targeters in rows 4 and 5 of figure 4, respectively.

In both industrial and emerging economies, inflation responds less to oil price shocks under a stationary target than before the adoption of inflation targeting (first rows of figures 5 and 6), but the differences are not statistically significant. However, the inflation response to an oil price shock is larger in industrial inflation targeters with a stationary target than in emerging-market inflation targeters with a stationary target. While the inflation reaction is positive and significant during the seven quarters after the oil price shock in industrial stationary inflation targeters, it is significant only until the first quarter in emerging-market stationary inflation targeters.

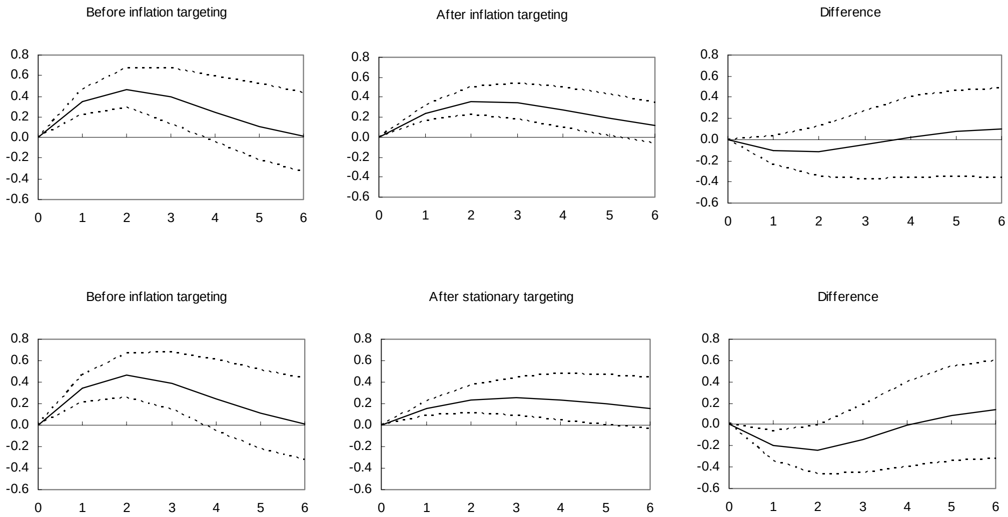
We now turn to the comparison of inflation targeters and nontargeters (the second and third rows of figures 5 and 6). In all inflation-targeting treatment groups, inflation responds less to oil price shocks than it does in nontargeters (after 1997), and this difference is significant by the sixth quarter, at the latest. In the case of emerging-market stationary inflation targeters, this difference is larger, earlier, and more significant than in the other inflation-targeting treatment groups: it is significant from the fourth to the sixth quarters (last row in figure 6). This last result shows that the performance in emerging stationary inflation targeters is the main force behind the results found for the full sample of inflation targeters (figure 4).

This comparative evidence on the inflation consequence of oil price shocks leads us to two main conclusions. First, inflation targeting helps all inflation targeters to reduce the domestic inflation response to an oil price shock relative to their own pre-targeting experience, although this reduction is not statistically different from zero. Second, in all inflation-targeting treatment groups, the inflation response to oil price shocks is smaller than in nontargeting countries after 1997. The difference in favor of inflation targeters is statistically significant, on average, at later quarters, reflecting smaller and less persistent effects of an oil shock on domestic inflation in inflation-targeting than in nontargeting countries. This result is particularly strong in emerging-market stationary inflation targeters, where the response of inflation to an oil price shock is the smallest and least persistent of all our subsamples.

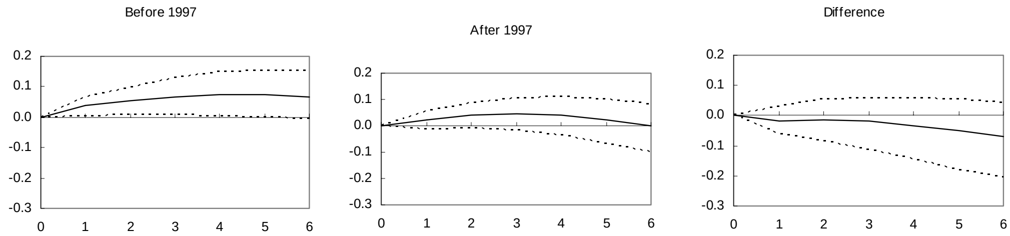
The response of inflation to innovations in the exchange rate provides a measure of the dynamics of devaluation-inflation pass-through. The positive response of inflation to exchange rate depreciation shocks is not much different before and after the adoption of inflation targeting in the full sample of inflation targeters (first row, figure 7). However, stationary-target inflation targeters show a larger decline in the response of inflation to exchange rate shocks, and this reduction is statistically significant in the first and second quarters after the shock. We observe a smaller response of inflation to exchange rate shocks in nontargeters after 1997 than in all inflation targeters and in stationary inflation targeters (fourth and fifth rows, figure 7). This result is statistically different from zero until the fourth quarter after the shock.

Figure 7: Response of Inflation to an Exchange Rate Shock: All Inflation Targeters

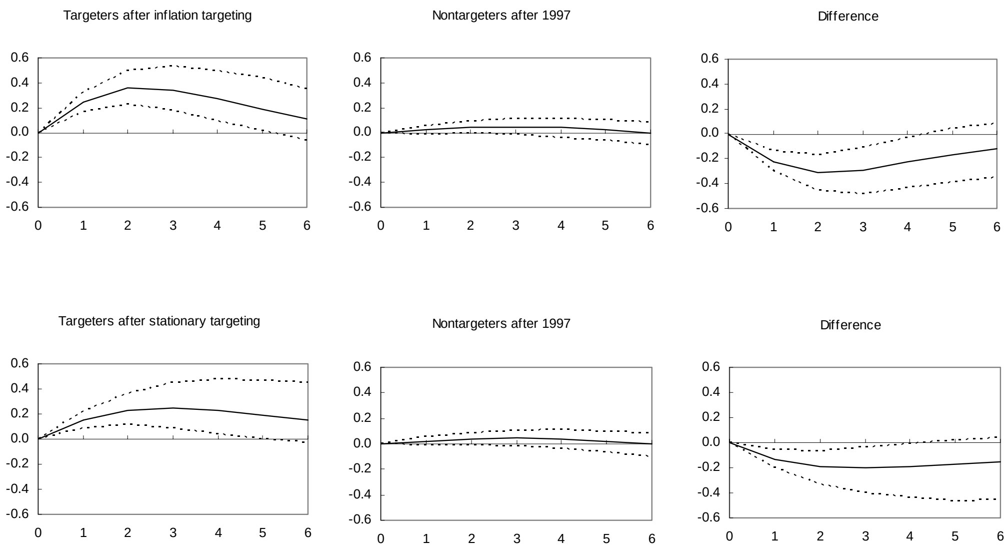
A. Inflation targeters



B. Nontargeters

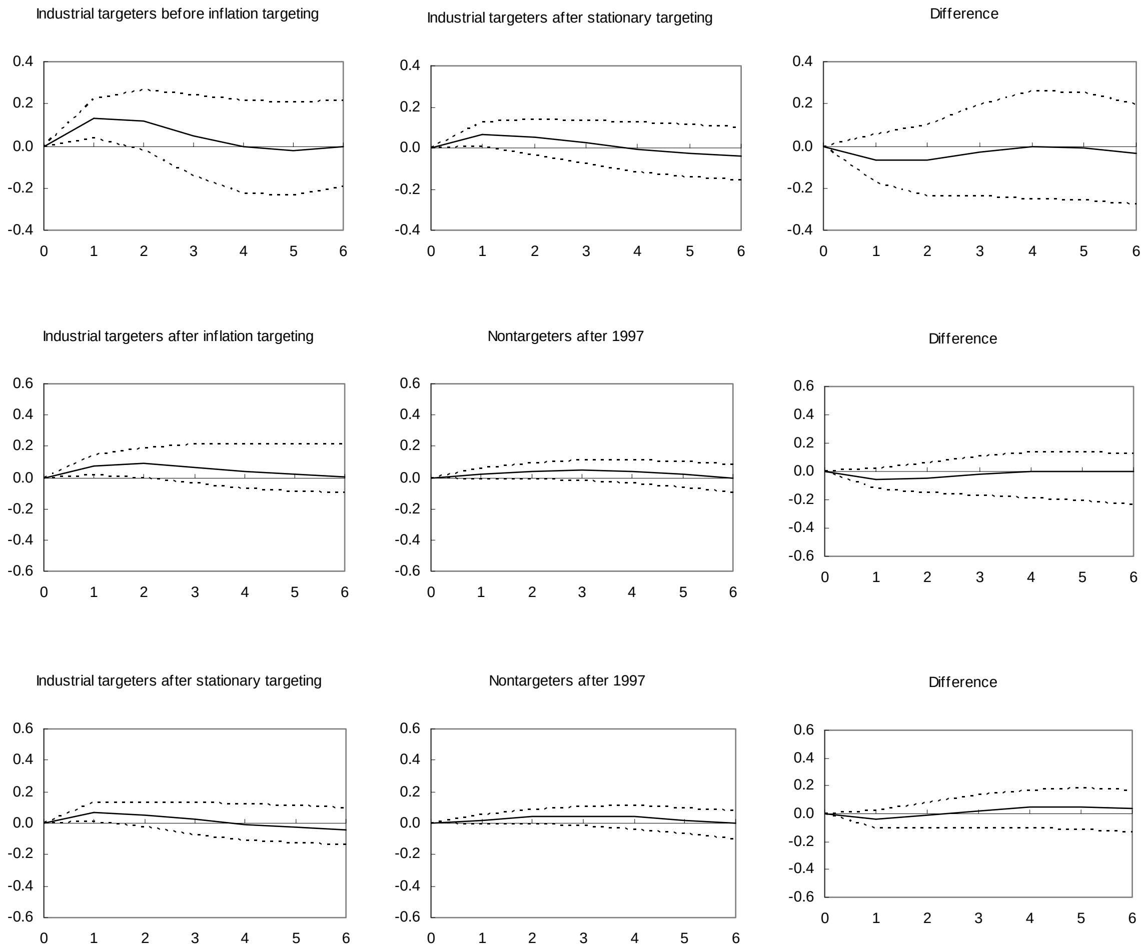


C. Inflation targeters versus nontargeters



Source: Author's estimations.

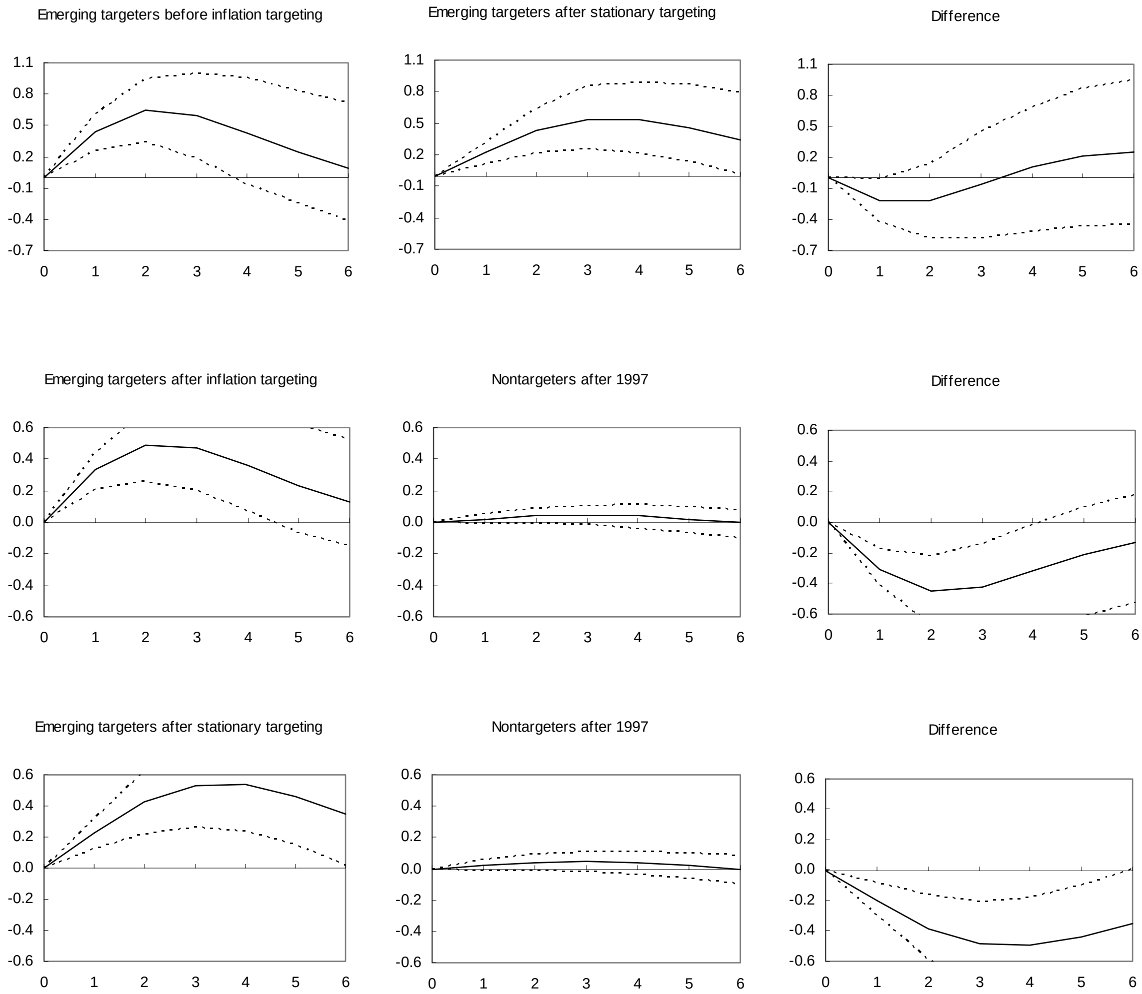
Figure 8: Response of Inflation to an Exchange Rate Shock: Industrial Inflation Targeters



Source: Author's estimations.

Next, we separate our treatment group into industrial and emerging inflation targeters (figures 8 and 9). Industrial inflation targeters (after inflation targeting) and industrial stationary inflation targeters exhibit a significantly smaller inflation response to exchange rate shocks than either emerging-market inflation targeters (after inflation targeting) or emerging stationary inflation targeters. Both industrial treatment groups (that is, all inflation targeters and stationary inflation targeters) display pass-through coefficients that are close to zero and insignificant in most periods. Both emerging-market treatment groups, in turn, register pass-through coefficients that are positive and significant at least until the fourth quarter after the shock. In industrial inflation targeters, the adoption of both inflation targeting and stationary-target inflation targeting has not made any difference to their pass-through coefficients, in comparison with their own pre-targeting experience and in comparison with nontargeters after 1997 (figure 8). In emerging-market economies, however, the comparisons yield very different results (figure 9). Short-term pass-through effects declined after the adoption of stationary targets in emerging economies, and the difference is significant in the first quarter after the exchange rate shock. Nevertheless, this reduction has not been sufficient to bring pass-through coefficients down to zero, as occurred among nontargeters after 1997. In fact, emerging-market inflation targeters and stationary inflation targeters exhibit much larger pass-through effects than nontargeters, and the differences are significant from quarters one through four (for all inflation targeters) and quarters one through six (for stationary inflation targeters).

Figure 9: Response of Inflation to an Exchange Rate Shock: Emerging Inflation Targeters



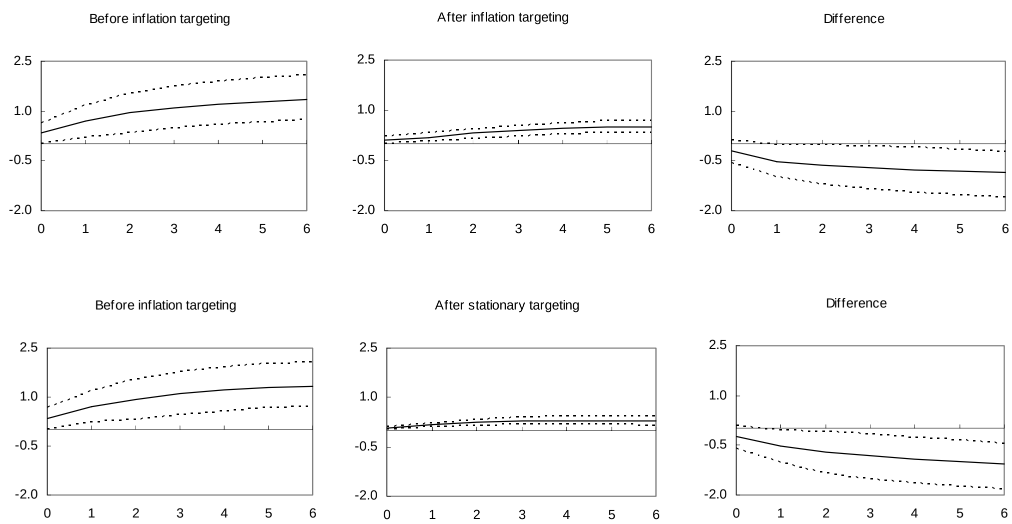
Source: Author's estimations.

We reach two conclusions from our comparison of the dynamics of pass-through effects from exchange rate shocks to domestic inflation. First, the adoption of inflation targeting has helped reduce the short-term pass-through somewhat under stationary-target inflation targeting, relative to the sample's own pre-targeting experience. This result, however, is entirely driven by emerging-market inflation targeters, where the pass-through coefficients fell somewhat after the countries achieved a stationary target but remain positive and significantly different from zero. Pass-through effects have been close to zero in industrial inflation targeters before and after inflation targeting and in nontargeters. Second, when comparing all inflation targeters and all stationary-target inflation targeters to nontargeters after 1997, the pass-through effects are significantly larger in both groups of targeters than in the nontargeters. This result is due to emerging-market inflation targeters, which exhibit much larger pass-through coefficients than nontargeters after 1997—and the differences are statistically significant from quarters one through five, on average. In contrast, industrial inflation targeters and nontargeters do not exhibit any significant differences in pass-through performance.

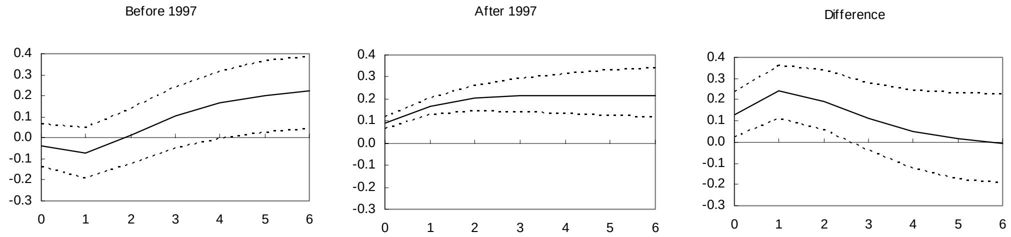
Finally, we consider the issue of comparative monetary independence, reflected by the response of domestic interest rates to shocks in international interest rates. In the pre-targeting period of inflation-targeting countries, the response of domestic interest rates to a shock in the international interest rate is very large, rises over time, and is statistically significant from impact through quarter six (first cell, figure 10). The positive response of the domestic interest rate to international interest rate shocks falls substantially in inflation targeters after they adopt inflation targeting and after they achieve stationary inflation targeting. In both cases, the decline in interest rate sensitivity is very large and statistically different from zero. Among nontargeters, interest rates react more strongly to international interest rates after 1997 than before, which may reflect the inclusion of a large number of euro area members in our control group. This difference is statistically significant only for the first two quarters after the shock. Interest rate sensitivity to foreign interest rate shocks is larger in inflation targeters and in stationary inflation targeters than in nontargeters after 1997; this difference is statistically different from zero in the case of all inflation targeters. This suggests that in the period of convergence, inflation targeting is not sufficient to achieve the level of monetary independence attained by nontargeters. However, interest rates in stationary inflation targeters respond to international interest rates at a similar magnitude as in nontargeters, since the difference in their impulse response functions is not statistically different from zero. Monetary independence under stationary inflation targeting has thus converged to the levels observed among nontargeters.

Figure 10: Response of the Domestic Interest Rate to an International Interest Rate Shock: All Inflation Targeters

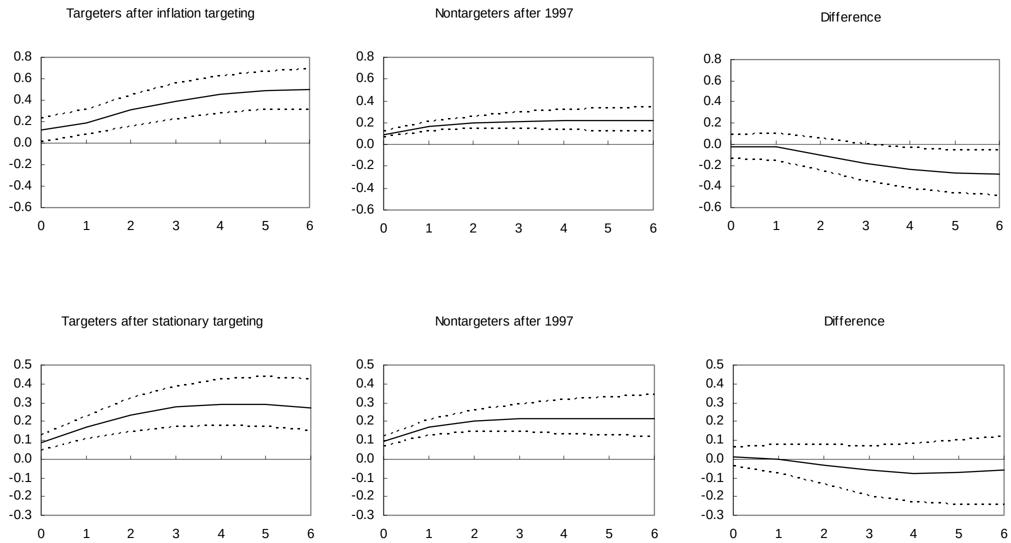
A. Inflation targeters



B. Nontargeters

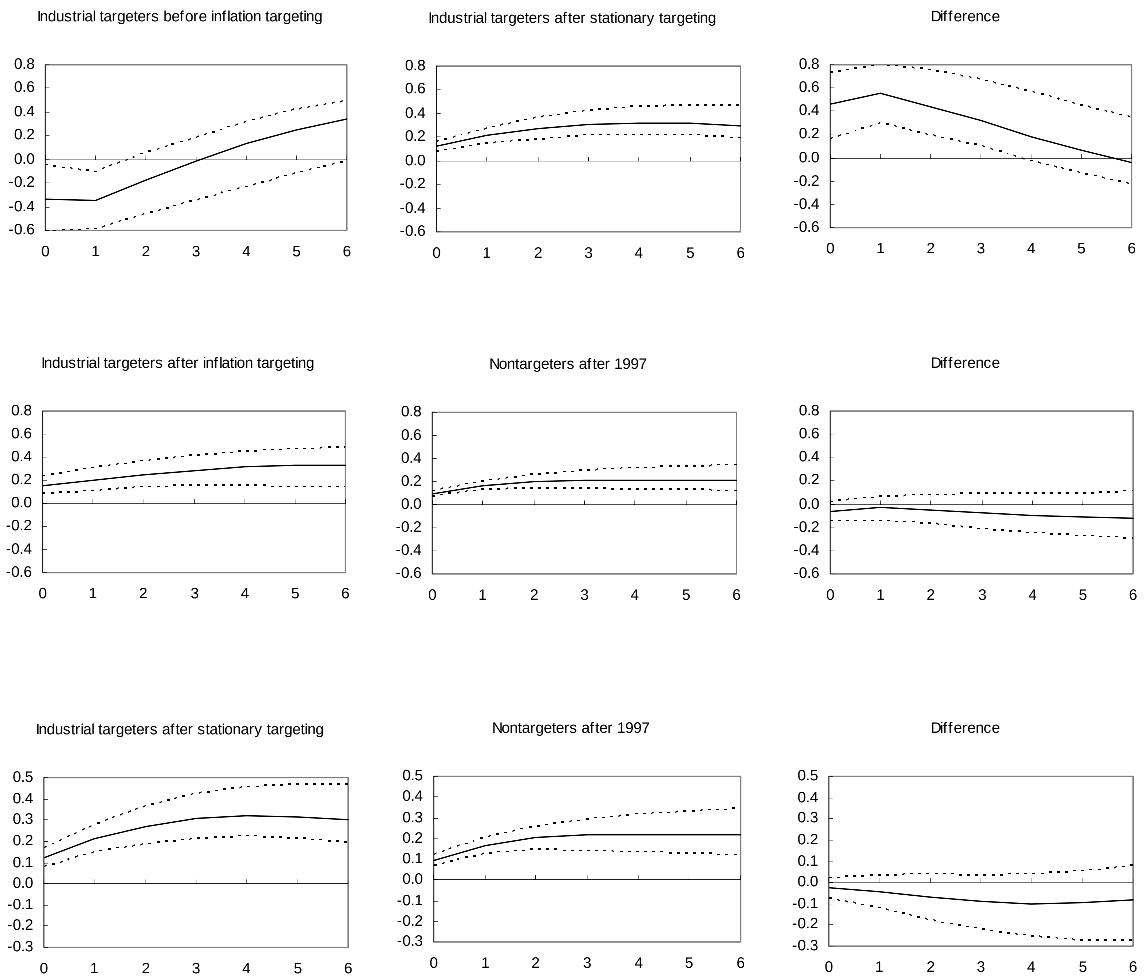


C. Inflation targeters versus nontargeters



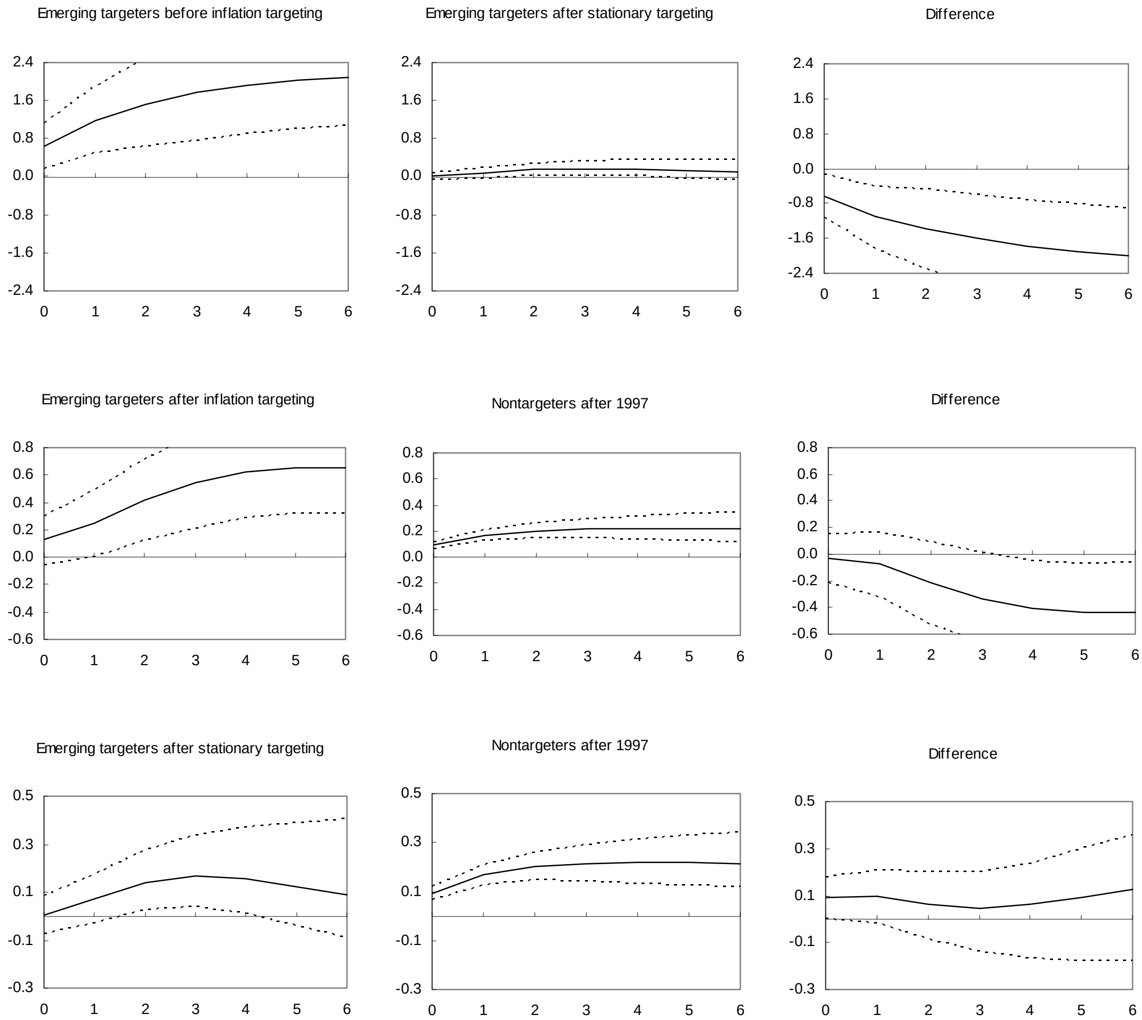
Source: Author’s estimations.

Figure 11: Response of the Domestic Interest Rate to an International Interest Rate Shock: Industrial Inflation Targeters



Source: Author's estimations.

Figure 12: Response of the Domestic Interest Rate to an International Interest Rate Shock: Emerging Inflation Targeters



Source: Author's estimations.

Our next task is to disaggregate industrial and emerging inflation targeters, since these two groups exhibit large and significant differences in monetary independence (see figures 11 and 12). The contrast in the domestic interest rate reaction to foreign interest rate shocks is striking in the pre-targeting period. While the response is negative and significant in the first quarters after the shock in the industrial pre-targeting experience, the response is positive, huge, increasing, and statistically significant in emerging-market countries. This points to a significant lack of monetary independence in the latter group before they adopted inflation targeting.

The results are quite different after the adoption of inflation targeting. In industrial stationary inflation targeters, the domestic interest rate sensitivity turns positive and is significantly larger in the first four quarters after the shock than it was before inflation targeting. This makes industrial inflation targeters more similar to nontargeters: there is no statistical difference in monetary independence between industrial inflation targeters (and industrial stationary inflation targeters) and nontargeters after 1997. In emerging inflation targeters, however, the adoption of inflation targeting massively reduces their interest rate sensitivity to foreign interest rate shocks. The size of the interest rate response declines by one order of magnitude after the start of inflation targeting, but it remains positive and significant from quarters one through six. Emerging-market inflation targeters attain a further reduction in interest rate sensitivity on achieving a stationary target: the response is now barely positive and only significant in quarters two to four after the foreign interest rate shock. Comparing emerging inflation targeters with post-1997 nontargeters yields a larger interest rate sensitivity (that is, significantly different from zero in quarters three to six) in the former group. Once emerging-market economies reach their stationary targets, their interest sensitivity declines further to levels that are numerically smaller but statistically not different from those observed among nontargeters after 1997.

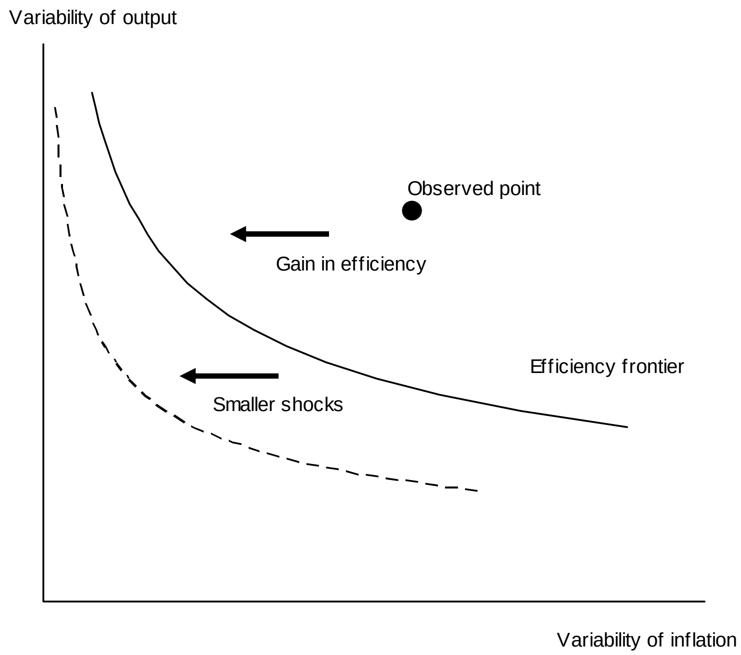
We conclude two points from our comparisons of dynamic responses of domestic interest rates to a shock in the international interest rate, which serves as a measure of monetary independence. First, the adoption of inflation targeting brought down interest rate sensitivity estimates for the full sample of inflation-targeting countries. However, this aggregate result hides two opposite changes. In industrial countries, interest rate sensitivity increased from negative to positive and significant with the adoption of inflation targeting. In contrast, in emerging-market inflation targeters, interest rate sensitivity declined from huge before inflation targeting to moderate during converging-target inflation targeting and to small under stationary-target inflation targeting. Second, inflation targeters are more similar to nontargeters as a result of these changes. While the sensitivity of interest rates to foreign interest rate shocks is slightly larger in industrial stationary inflation targeters than in nontargeters, and slightly smaller in emerging-market stationary inflation targeters than in nontargeters, the differences are not statistically significant. Our measure of monetary independence thus reflects a convergence of inflation-targeting countries that have achieved stationary targets to the levels exhibited by nontargeters.

4. Inflation Volatility, Output Volatility, and Monetary Policy Efficiency

One way of gauging macroeconomic performance is to focus on the stability of inflation and real growth. The evidence reported in tables 2 and 3 shows that standard deviations of inflation and the output gap are larger in inflation targeters than in nontargeters. One possible explanation is that nontargeters are hit by smaller shocks. Alternatively, nontargeters' central banks may be more efficient at implementing policies to meet their stabilization objectives. In this section, we compute performance measures to identify the contribution of different monetary policy strategies to the observed differences in macroeconomic performance between inflation targeters and nontargeters. Following Cecchetti and Krause (2002) and Cecchetti, Flores-Lagunes, and Krause (2006), we estimate an inflation and output variability efficiency frontier that allows us to derive measures of economic performance and monetary policy efficiency.

The performance of monetary policy can be assessed using the inflation and output variability trade-off faced by the policymaker. This trade-off allows us to construct an efficiency frontier known as the Taylor curve (Taylor, 1979). The inflation-output variability frontier is understood by considering an economy that is hit by two types of disturbances: aggregate demand and aggregate supply shocks. Aggregate supply shocks move output and inflation in opposite directions, forcing the monetary authority to face a trade-off between inflation and output variability. The position of the efficiency frontier therefore depends on the intensity of aggregate supply shocks: the smaller the shocks, the closer is the frontier to the origin (see figure 13).

Figure 13: Monetary Policy Efficiency Frontier and Performance Point



Source: Authors.

The efficiency frontier is also an indicator of the degree of optimality of monetary policy. When monetary policy is suboptimal, the economy will exhibit large output and inflation volatility and will be located at a significant distance from the frontier. Movements toward the efficiency frontier indicate improved monetary policy (figure 13). These features of the efficiency frontier allow us to construct measures of economic and monetary policy performance to examine the contribution of policy efficiency and the variability of shocks to the observed differences in macroeconomic performance between different samples of nontargeters and inflation targeters.

We closely follow the methodology derived by Cecchetti, Flores-Lagunes, and Krause (2006). We do not apply their method to individual countries, however, but rather to inflation-targeting and nontargeting country groups. We start by obtaining a measure of an economy's performance in terms of output and inflation variability. Specifically, we derive a standard conventional central bank objective, which is to minimize the following loss function determined by quadratic inflation and output deviations:

$$L = \lambda\left(\pi_t - \pi_t^*\right)^2 + \left(1-\lambda\right)\left(y_t - y_t^*\right)^2, \tag{5}$$

where π_t is the inflation rate, π_t^* is the inflation target or objective, y_t is the log level of output, y_t^* is the target or trend level of output, and λ is the policymaker's weight attached to inflation. Hence our measure of macroeconomic performance, L, is a weighted average of observed variability of inflation and output with respect to their target levels.

The difference between the observed performance measures of nontargeters (L_{NIT}) and inflation targeters (L_{IT}) reflects differences in macroeconomic outcomes. If $\Delta L = L_{\mathrm{NIT}} - L_{\mathrm{IT}}$ is negative, then nontargeters present a better macroeconomic performance than inflation targeters. We similarly interpret the comparison of inflation targeters before and after they adopted inflation targeting. If $\Delta L = L_{\text{post-IT}} - L_{pre\text{-IT}}$ is negative, then inflation targeters recorded a performance gain after the adoption of inflation targeting.

This change in performance can reflect either a change in the position of the efficiency frontier (that is, a better performance is explained only by smaller supply shocks) or a change in monetary policy efficiency or both. The change in performance due to the change in the size of shocks is derived from the following combination of the optimal variances of output and inflation:

$$S = \lambda\overline{\left(\pi_t - \pi_t^*\right)^2} + \left(1-\lambda\right)\overline{\left(y_t - y_t^*\right)^2}, \tag{6}$$

where $\overline{\left(\pi_t - \pi_t^*\right)^2}$ and $\overline{\left(y_t - y_t^*\right)^2}$ are the deviations of inflation and output from their targets under an optimal policy, respectively. S is the measure of supply shocks variability. Therefore, the smaller the variability of the disturbances that hit the economy, the closer is the efficiency frontier to the origin and the smaller is the latter measure. For example, a negative difference of this measure between nontargeters and inflation targeters, $\Delta S = S_{\text{NIT}} - S_{\text{IT}}$, indicates that the shocks hitting nontargeters are smaller. Alternatively, a negative value of $\Delta S = S_{\text{post-IT}} - S_{pre\text{-IT}}$ implies that inflation targeters face smaller shocks after the adoption of inflation targeting.

Finally, we evaluate the efficiency of monetary policy by measuring how close actual performance is to performance under optimal policy (that is, the distance to the efficiency frontier). We label this measure E and define it as follows:

$$E = \lambda\left[\left(\pi_t - \pi_t^*\right)^2 - \overline{\left(\pi_t - \pi_t^*\right)^2}\right] + \left(1-\lambda\right)\left[\left(y_t - y_t^*\right)^2 - \overline{\left(y_t - y_t^*\right)^2}\right]. \tag{7}$$

Hence, the smaller the value of E, the closer monetary performance is to optimal policy. Differences in policy efficiency between nontargeters and targeters are obtained by computing $\Delta E = E_{\text{NIT}} - E_{\text{IT}}$; a negative value of ΔE implies that nontargeters' policy is more efficient. Similarly, the change in policy efficiency of inflation targeters over time is computed as $\Delta E = E_{\text{post-IT}} - E_{pre\text{-IT}}$, which is negative if inflation targeters improved their policy efficiency.

Computation of these performance measures requires empirical estimates of the output-inflation variability frontier. We first need to derive a policy reaction function from minimization of the loss function, subject to the constraints imposed by the structure of the economy. Given this solution and a value for the weight of inflation in the policymaker's loss function (λ), we are able to plot a point on the efficiency frontier. Varying the weight assigned to the variability of inflation allows us to trace the entire efficiency frontier. We proceed in two main steps: we estimate a simple dynamic aggregate demand and supply model, and we then use this estimate to construct the efficiency frontier.

We consider a simple dynamic panel aggregate demand and supply model similar to the one used in Rudebusch and Svensson (1999). The model consists of the following two equations:

$$y_{i,t} = \sum_{j=1}^{p} \phi_{1,j} i_{i,t-j} + \sum_{j=1}^{p} \phi_{1,(p+j)} y_{i,t-j} + \sum_{j=1}^{p} \phi_{1,(2p+j)} \pi_{i,t-j} + \sum_{i=j}^{p} \phi_{1,(3p+j)} px_{i,t-j} + \sum_{i=j}^{p} \phi_{1,(4p+j)} \text{oil}_{t-j} + \upsilon_{1,i} + \varepsilon_{1,i,t}; \quad (8)$$

$$\pi_{i,t} = \sum_{j=1}^{p} \phi_{1,j} y_{i,t-j} + \sum_{j=1}^{p} \phi_{1,(p+j)} \pi_{i,t-j} + \sum_{i=j}^{p} \phi_{1,(2p+j)} px_{i,t-j} + \sum_{i=j}^{p} \phi_{1,(3p+j)} \text{oil}_{t-j} + \upsilon_{2,i} + \varepsilon_{2,i,t}. \quad (9)$$

The first equation reflects an aggregate demand function, where detrended output ($y_{i,t}$) for country i at time t is explained by p own lags, p lags of the nominal interest rate ($i_{i,t}$), and inflation deviations from targets or objectives ($\pi_{i,t}$). We also include p lags of two exogenous variables, the deviation of the oil price from trend (oil_t) and external price inflation ($px_{i,t}$), as well as a country fixed effect ($v_{1,t}$).[19] The second equation represents a Phillips curve, in which inflation deviations from its target or objective are a function of p own lags, p lags of detrended output, p lags of the deviation of the oil price from trend, p lags of the deviation of external inflation from trend, and a country fixed effect. Finally, $\varepsilon_{1,i,t}$ and $\varepsilon_{2,i,t}$ represent the error terms. We estimate both equations for a group of countries (for example, nontargeters and targeters) using the generalized method of moments (GMM) for dynamic panels (Arellano and Bond, 1991).

Having estimated the dynamics of the economy, we proceed to obtain the optimal monetary policy function. The central bank selects a path for the interest rate from the minimization of its loss function subject to the dynamics of the economy:

$$\min \hat{E}(L) = \hat{E}\left[\left(\pi_t - \pi_t^*\right)^2 + (1-\lambda)\left(y_t - y_t^*\right)^2\right] = \hat{E}\left(\mathbf{Y}_t' \Lambda \mathbf{Y}_t\right), \quad (10)$$

subject to

$$\mathbf{Y}_t = \mathbf{B}\mathbf{Y}_{\mathbf{t-1}} + \mathbf{c}i_{t-1} + \mathbf{D}\mathbf{X}_{t-1} + \mathbf{v}_t, \quad (11)$$

where $Y_t = (i_{t-1}, y_t, y_{t-1}, \pi_t, \pi_{t-1})'$, $X_t = (px_t, \text{oil}_t)'$, $v_t = (0, \varepsilon_{1,t}, 0, \varepsilon_{2,t}, 0)'$, B and D are matrices of the estimated coefficients of the aggregate demand and supply equations, Λ is a matrix of the weights attached to output and inflation variability, and $\hat{E}$ is the expectation conditional on information available at time t. The solution to this optimal control problem yields an optimal path for the interest rate:

$$i_t = \mathbf{\Gamma}\mathbf{Y}_t + \Psi, \quad (12)$$

where $\Gamma = -(c'Hc)^{-1}c'HB$ with $H = \Lambda + (B + c\Gamma)'H(B + c\Gamma)$, and ψ is a constant term that depends on B, c and D. Using this result, we calculate the optimal variances of output and inflation, obtaining a point on the efficiency frontier for each value of λ.

With the estimated efficiency frontier at hand, we determine the optimal variances of inflation and output that are required to compute performance measures. We calculate the ratio of the observed volatilities of output and inflation and then identify the point on the frontier that implies this variability ratio. This is similar to performing a homothetic shift of the frontier so that it passes through the data point determined by the observed variances of output and inflation.

[19] External inflation is defined as the sum of the annualized nominal exchange rate devaluation and the annual inflation rate of the United States.

Consistent with our measures in the other sections of the paper, here our measures of inflation volatility are based on the deviation of CPI inflation from the inflation target for inflation targeters and from a Hodrick-Prescott (HP) trend for nontargeters. For both country groups, output volatility is based on the output gap or deviation from an HP trend.

We are now able to compute the performance measures presented above in order to disentangle the contribution of changes in monetary policy efficiency and supply shocks to the observed differences in macroeconomic performance between different country groups. As in other sections of the paper, we compare the performance between five groups of countries: inflation targeters before and after the adoption of inflation targeting; inflation targeters before they adopted inflation targeting and after they achieved a stationary target; nontargeters before and after the mean inflation-targeting adoption date (first quarter of 1997); inflation targeters vis-à-vis nontargeters after the first quarter of 1997; and stationary inflation targeters versus nontargeters after the first quarter of 1997. As above, we also present results for all inflation targeters and for industrial and emerging inflation targeters.

Table 9 reports the estimated comparative measures of economic performance, L, monetary policy efficiency, E, and the variability of supply shocks, S, for each pair of country groups. Figures 14 through 26 depict actual performance points, L, and efficiency frontiers consistent with E for each pair of country groups. We follow Cecchetti, Flores-Lagunes, and Krause (2006) in using a value of λ—that is, the weight attached to inflation deviations in the loss function—equal to 0.80. This value is consistent with the empirical estimates for inflation-targeting and nontargeting countries reported by Cecchetti and Ehrmann (2002) and Corbo, Landerretche, and Schmidt-Hebbel (2002).

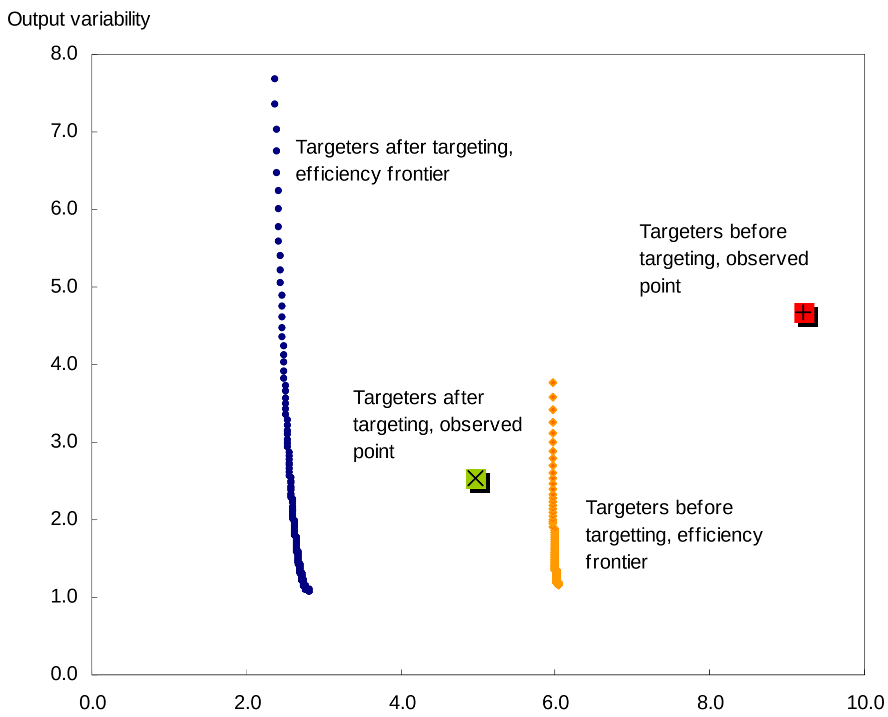
Row 1a of table 9 reports the estimated measures for all inflation targeters, before and after the adoption of inflation targeting. Figure 14 depicts the corresponding positions or observed combinations of output and inflation variability, as well as the efficiency frontiers observed before and after inflation-targeting adoption. Macroeconomic performance improved between these periods, as inflation and output volatility shrank. This is reflected by the inward shift of observed points or positions before and after inflation-targeting adoption in figure 14. The corresponding performance gain is reflected by a negative value of $\Delta L = L2 - L1$, at –3.817, in row 1a. The latter improvement disaggregates into a gain in efficiency, $\Delta E = E2 - E1$ (by –0.882, equivalent to a 23.1 percent contribution to the overall performance gain), which is reflected in a movement closer to the efficiency frontier, and a reduction in the variability of shocks hitting the economy, $\Delta S = S2 - S1$ (by –2.935, equivalent to a 76.9 percent contribution), which is reflected in a shift of the efficiency frontier. Another way to confirm the contribution of shocks and policy efficiency to the initial and final positions, $L1$ and $L2$, is to quantitatively decompose the latter position, summarized in the second line of row 1a in table 9. Efficiency ($E1$) explains 35.3 percent of pre-targeting performance ($L1$), a share that rises to 45.7 percent after the adoption of inflation targeting.

Table 9: Changes in Performance and Policy Efficiency over Time and between Targeters and Nontargeters

Sample Group 1	*L1*	*E1*	*S1*	**Sample Group 2**	*L2*	*E2*	*S2*	**Change** *L2 – L1*	*E2 – E1*	*S2 – S1*
1a. Targeters before targeting	8.302	2.931	5.371	Targeters after targeting	4.485	2.048	2.436	–3.817	–0.882	–2.935
(as % of L)		35.3	64.7	(as % of L)		45.7	54.3		23.1	76.9
1b. Industrial targeters before targeting	1.952	0.398	1.553	Industrial targeters after targeting	1.752	0.786	0.966	–0.199	0.388	–0.587
(as % of *L*)		20.4	79.6	(as % of L)		44.9	55.1		–194.3	294.3
1c. Emerging targeters before targeting	11.863	5.308	6.555	Emerging targeters after targeting	6.657	3.098	3.559	–5.206	–2.211	–2.995
(as % of *L*)		44.7	55.3	(as % of L)		46.5	53.5		42.5	57.5
2a. Targeters before targeting	8.302	2.931	5.371	Stationary targeters	2.007	0.780	1.227	–6.296	–2.151	–4.145
(as % of L)		35.3	64.7	(as % of L)		38.9	61.1		34.2	65.8
2b. Industrial targeters before targeting	1.952	0.398	1.553	Industrial stationary targeters	1.358	0.524	0.834	–0.593	0.126	–0.719
(as % of *L*)		20.4	79.6	(as % of L)		38.6	61.4		–21.3	121.3
2c. Emerging targeters before targeting	11.863	5.308	6.555	Emerging stationary targeters	3.547	1.850	1.697	–8.316	–3.459	–4.857
(as % of *L*)		44.7	55.3	(as % of L)		52.1	47.9		41.6	58.4
3. Nontargeters before 1997	0.869	0.129	0.740	Nontargeters after 1997	0.571	0.268	0.303	–0.298	0.139	–0.437
(as % of L)		14.9	85.1	(as % of L)		47.0	53.0		–46.9	146.9
4a. Targeters after targeting	4.485	2.048	2.436	Nontargeters after 1997	0.571	0.268	0.303	–3.913	–1.780	–2.134
(as % of L)		45.7	54.3	(as % of L)		47.0	53.0		45.5	54.5
4b. Industrial targeters after targeting	1.752	0.786	0.966	Nontargeters after 1997	0.571	0.268	0.303	–1.181	–0.517	–0.663
(as % of *L*)		44.9	55.1	(as % of L)		47.0	53.0		43.8	56.2
4c. Emerging targeters after targeting	6.657	3.098	3.559	Nontargeters after 1997	0.571	0.268	0.303	–6.086	–2.829	–3.257
(as % of *L*)		46.5	53.5	(as % of L)		47.0	53.0		46.5	53.5
5a. Stationary targeters	2.007	0.780	1.227	Nontargeters after 1997	0.571	0.268	0.303	–1.435	–0.511	–0.924
(as % of L)		38.9	61.1	(as % of L)		47.0	53.0		35.6	64.4
5b. Industrial stationary targeters	1.358	0.524	0.834	Nontargeters after 1997	0.571	0.268	0.303	–0.787	–0.3	–0.5
(as % of *L*)		38.6	61.4	(as % of L)		47.0	53.0		32.5	67.5
5c. Emerging stationary targeters	3.547	1.850	1.697	Nontargeters after 1997	0.571	0.268	0.303	–2.976	–1.581	–1.395
(as % of *L*)		52.1	47.9	(as % of L)		47.0	53.0		53.1	46.9

Source: Author's estimations.

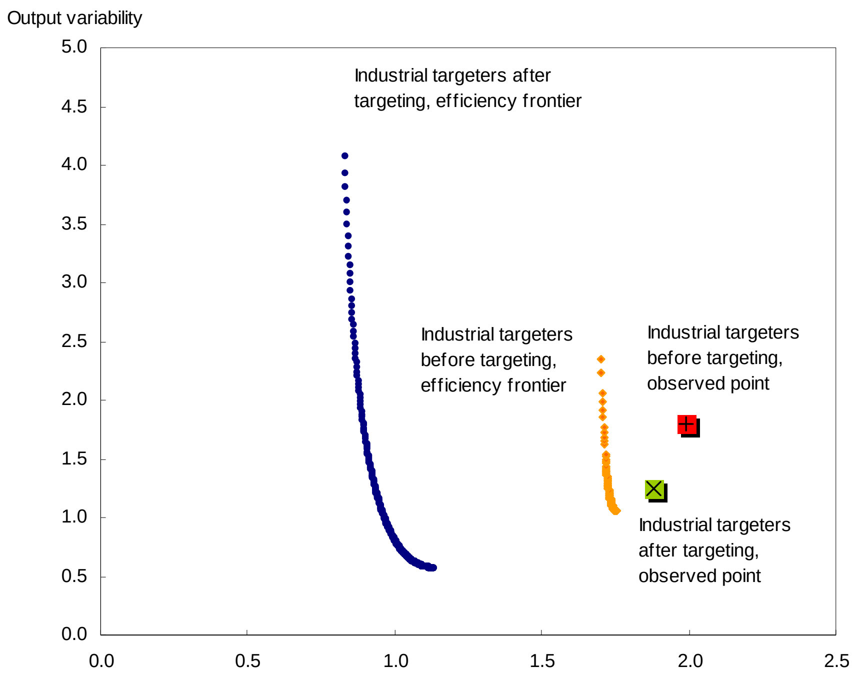
Figure 14: Estimated Efficiency Frontiers and Observed Performance Points: All Targeters before and after Inflation



Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

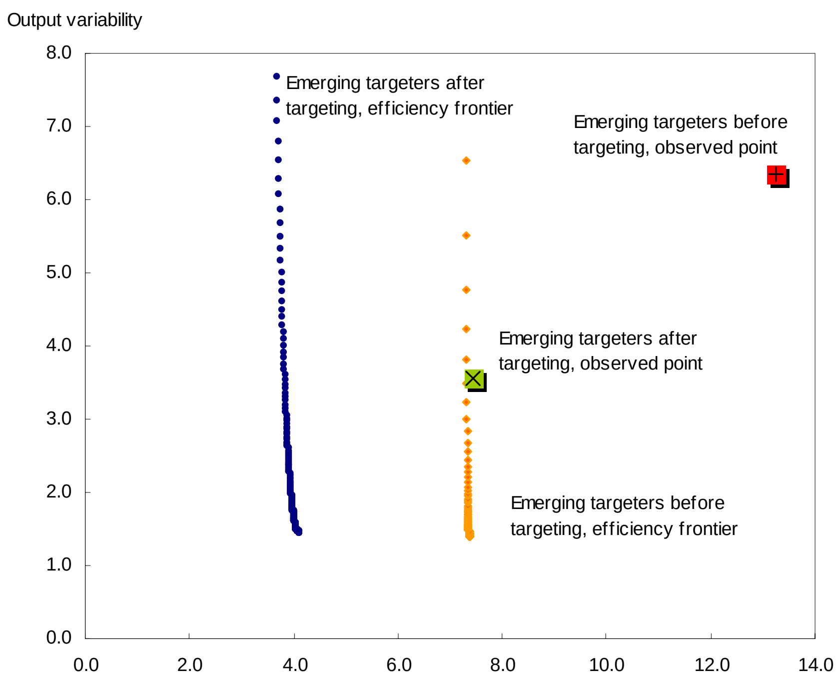
Rows 2a and 2b report the corresponding before-and-after comparisons for industrial and emerging inflation targeters. The variability of inflation and output is much larger in emerging than in industrial inflation targeters both before and after adoption of inflation targeting. For example, position *L*2 (after the adoption of inflation targeting) reflects a combination of inflation and output variability of 6.657 for emerging inflation targeters, versus 1.752 for industrial inflation targeters. Similar differences are observed in the efficiency frontier positions of industrial and emerging inflation targeters: the former are much closer to the origin than the latter (compare figures 15 and 16). In both country groups, however, macroeconomic performance improved with the adoption of inflation targeting. Industrial inflation targeters observed a small improvement, with ΔL equaling –0.199. This change results from two counteracting processes: a reduction in policy efficiency that deteriorated macroeconomic performance (lowering the observed gain by 194.3 percent) and a reduction in the variability of shocks that shifted the efficiency frontier significantly inward (which explains 294.3 percent of the performance gain). In contrast, emerging inflation targeters experienced a much larger macroeconomic improvement following the adoption of inflation targeting (ΔL is –5.206). This reflects both increased policy efficiency (contributing 42.5 percent) and a lower exposure to shocks (contributing 57.5 percent).

Figure 15: Estimated Efficiency Frontiers and Observed Performance Points: Industrial Targeters before and after Inflation Targeting



Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

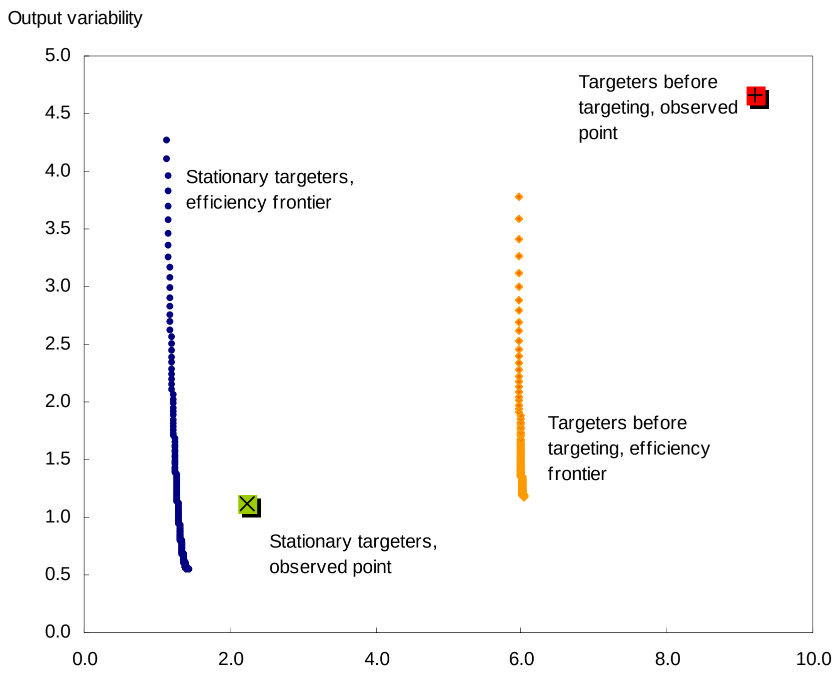
Figure 16: Estimated Efficiency Frontiers and Observed Performance Points: Emerging Targeters before and after Inflation Targeting



Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

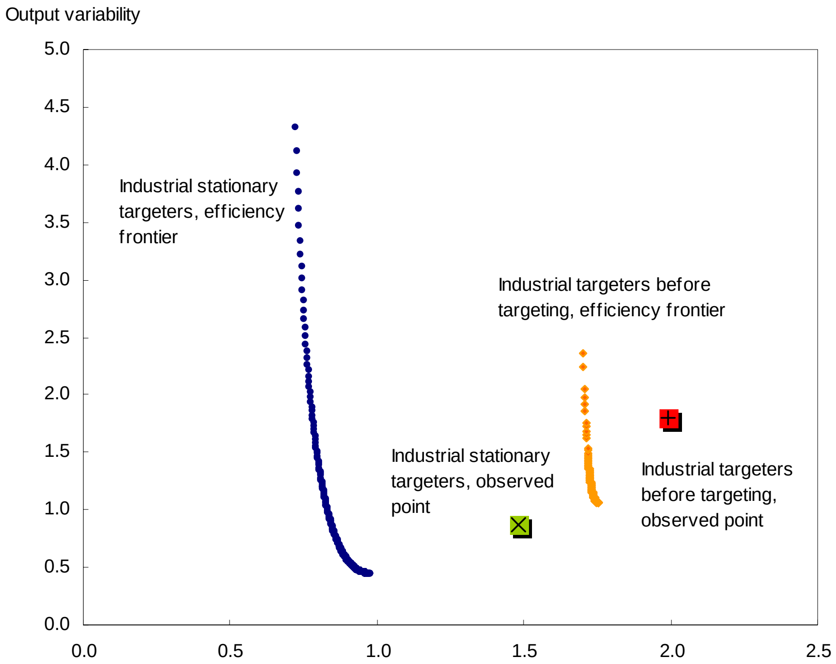
The next comparison is between pre-targeting and stationary-targeting performance (rows 2a, 2b, and 2c in table 9 and figures 17, 18, and 19). We find that inflation targeters reap a much larger improvement in macroeconomic performance once they achieve stationary inflation targets. The efficiency frontier position of stationary targeters has shifted much closer to the origin than was the case for all inflation targeters (both converging and stationary) discussed above (figure 17). Moreover, the relative contribution of efficiency improvements to the performance gain when adopting stationary inflation targeting is larger (34.2 percent) than the corresponding contribution of efficiency improvements when adopting inflation targeting in general (23.1 percent). As in the case of the full inflation-targeting sample, emerging stationary inflation targeters register a much larger gain than industrial stationary inflation targeters (rows 2b and 2c of table 9 and figures 18 and 19). The benefits reaped by emerging economies, however, are much larger for the sample of stationary targeters than for the full sample.

Figure 17: Estimated Efficiency Frontiers and Observed Performance Points: All Targeters before Inflation Targeting and Stationary-Target Targeters



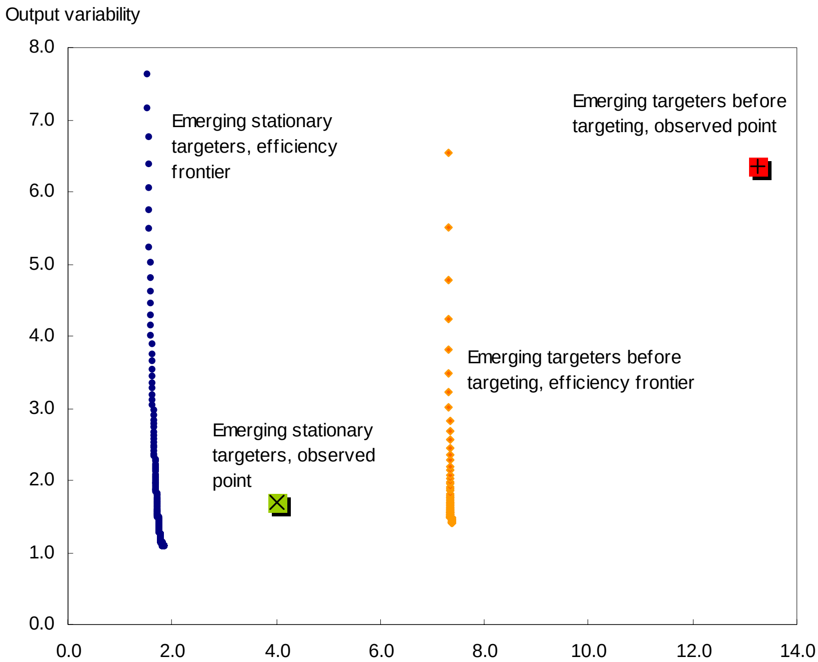
Source: Author’s estimations.
Note: Inflation variability on the horizontal axis.

Figure 18: Estimated Efficiency Frontiers and Observed Performance Points: Industrial Targeters before Inflation Targeting and Industrial Stationary-Target Targeters



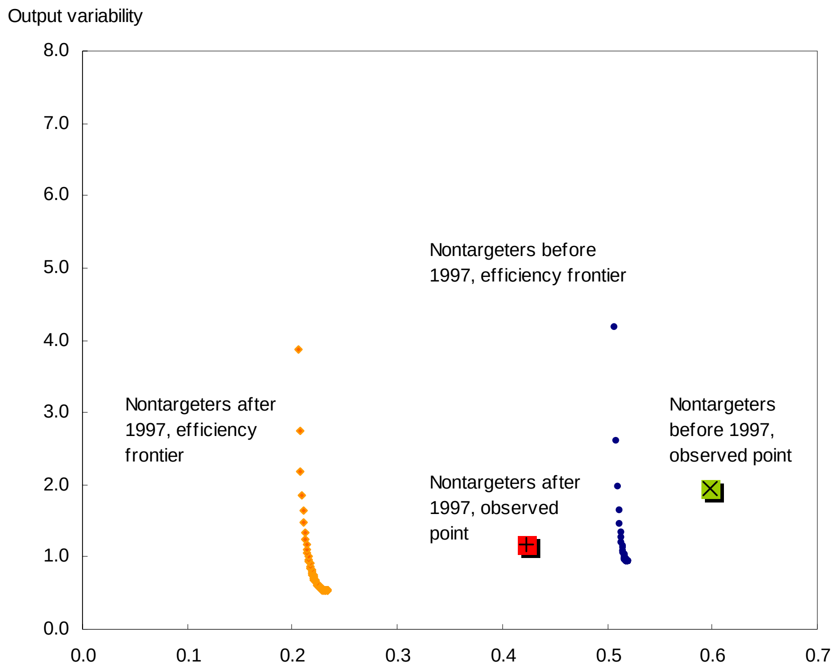
Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 19: Estimated Efficiency Frontiers and Observed Performance Points: Emerging Targeters before Inflation Targeting and Emerging Stationary-Target Targeters



Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 20: Estimated Efficiency Frontiers and Observed Performance Points: Nontargeters before and after 1997

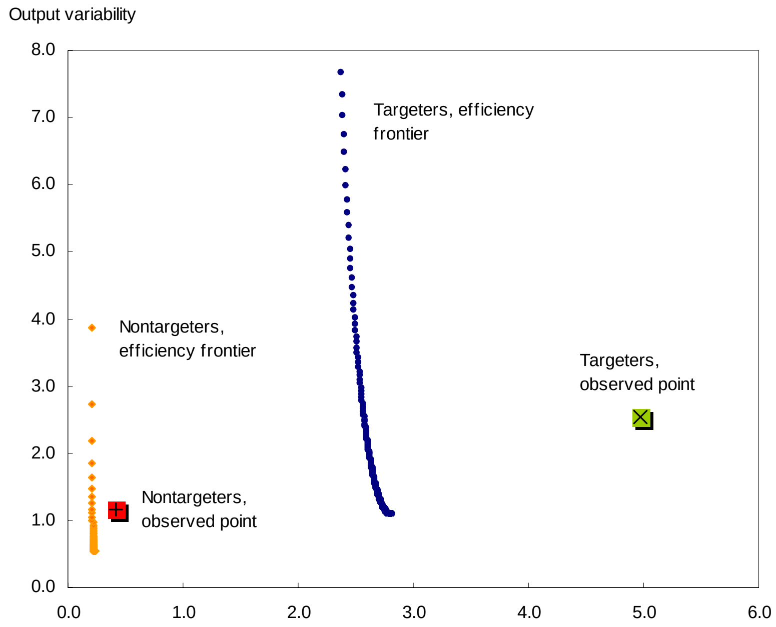


Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

The third comparison is for nontargeters before and after the first quarter of 1997 (see row 3 in table 9 and figure 20). As in our previous comparisons, nontargeters record an improvement in macroeconomic performance in the later period. The reduction in their output and inflation volatility, however, is more than fully explained by a decrease in the size of shocks, while monetary policy efficiency deteriorated. This pattern parallels that seen for industrial targeters above. Therefore, both inflation-targeting and nontargeting industrial economies display a common feature: supply shocks weakened significantly after the adoption of inflation targeting or after 1997, which explains more than 100 percent of their observed macroeconomic performance gains. This stands in contrast to emerging inflation targeters, where both weaker supply shocks and improved policy efficiency contributed to their (much larger) performance gains.

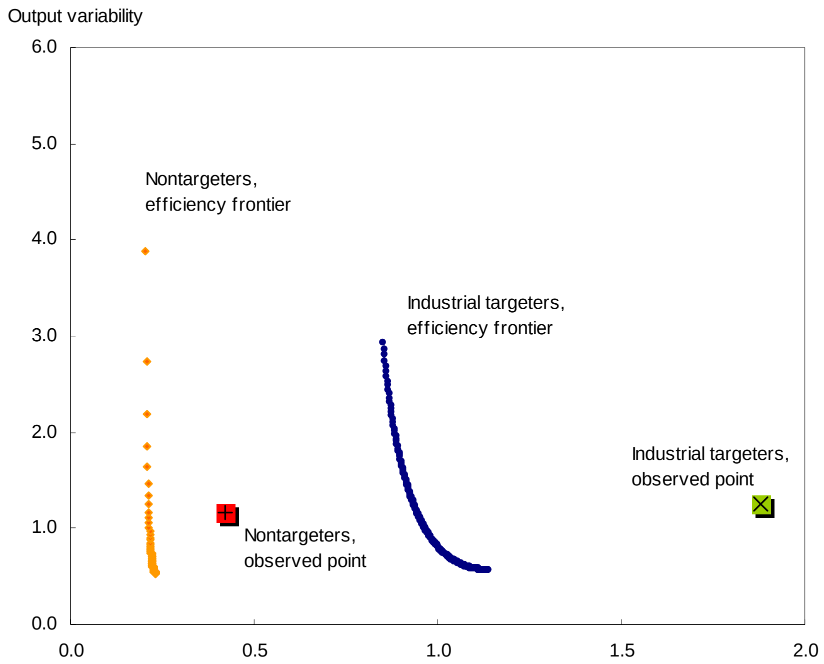
Next we compare inflation targeters after the adoption of inflation targeting and nontargeters after 1997. We use the performance changes over time observed for our treatment and control groups separately to compare macroeconomic performance across our treatment and control groups. We compare the performance of all inflation targeters (including both converging and stationary inflation targeters) and nontargeters (rows 4a, 4b, and 4c in table 9 and figures 21, 22, and 23) and of stationary inflation targeters and nontargeters (rows 5a, 5b, and 5c in table 9 and figures 24, 25, and 26). A general result is that the full sample of inflation targeters (both converging and stationary targeters) exhibit actual performance levels, efficiency frontier positions, and policy efficiency levels that are worse than those of nontargeters. However, stationary inflation targeters are much closer to the performance and efficiency levels of nontargeters than is the full sample. The difference in performance between nontargeters and stationary targeters (–1.435; see row 5a) is due primarily to larger shocks in stationary inflation targeters (explaining 64.4 percent of the performance difference) and, to a lesser degree, to less efficient policy among inflation targeters (explaining 35.6 percent).

Figure 21: Estimated Efficiency Frontiers and Observed Performance Points: All Targeters and Nontargeters after 1997



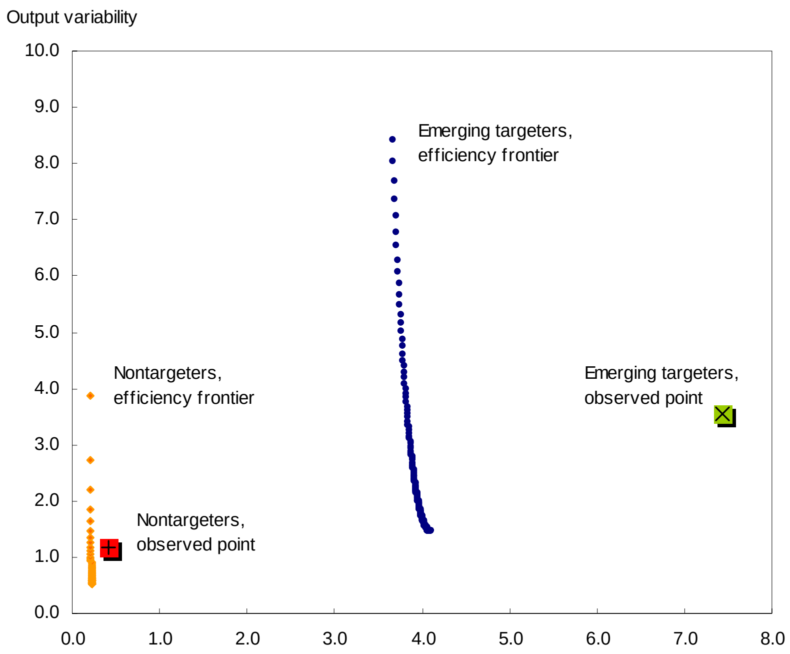
Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 22: Estimated Efficiency Frontiers and Observed Performance Points: Industrial Targeters and Nontargeters after 1997



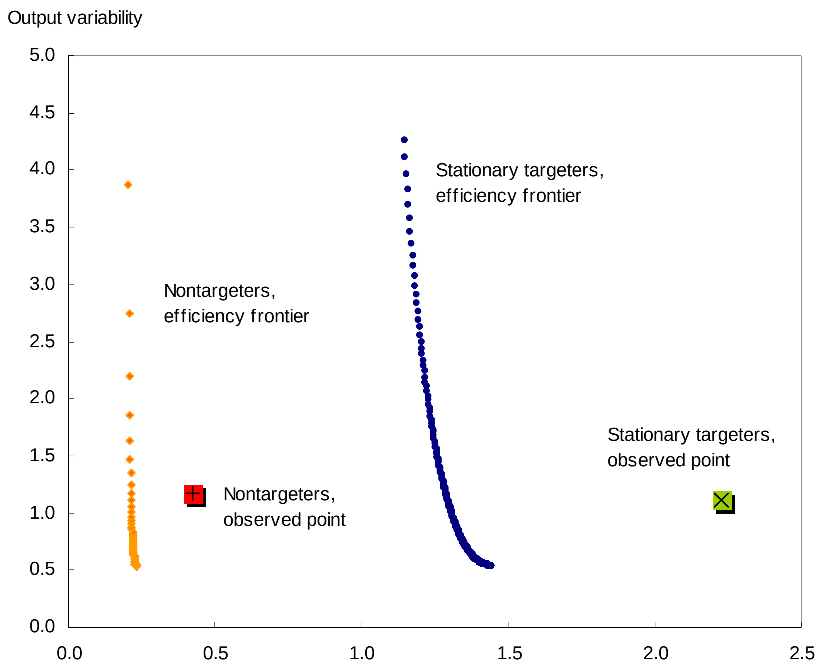
Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 23: Estimated Efficiency Frontiers and Observed Performance Points: Emerging Targeters and Nontargeters after 1997



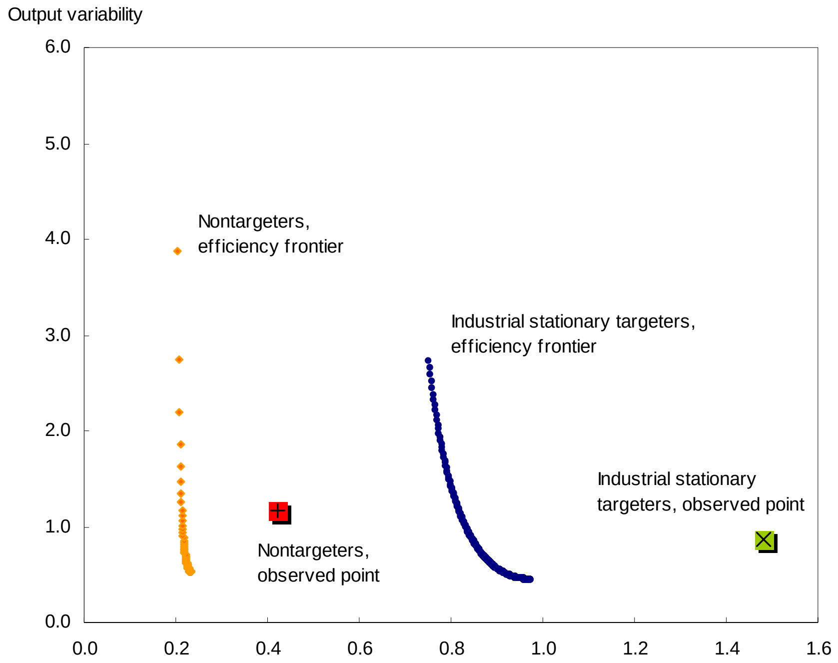
Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 24: Estimated Efficiency Frontiers and Observed Performance Points: Stationary Targeters and Nontargeters after 1997



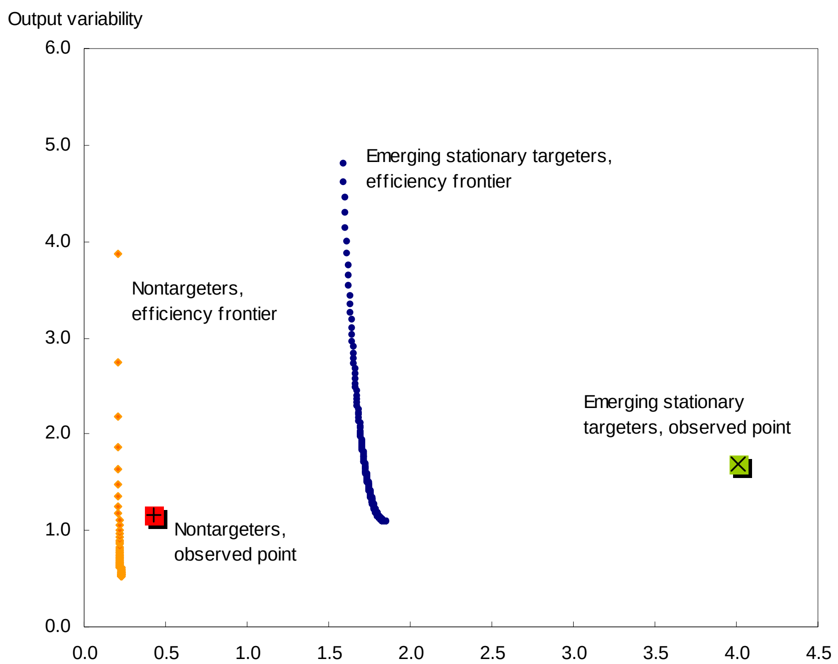
Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 25: Estimated Efficiency Frontiers and Observed Performance Points: Industrial Stationary Targeters and Nontargeters after 1997



Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

Figure 26: Estimated Efficiency Frontiers and Observed Performance Points: Emerging Stationary Targeters and Nontargeters after 1997



Source: Author's estimations.
Note: Inflation variability on the horizontal axis.

When we disaggregate the inflation targeters into emerging and industrial countries, we find that the difference between nontargeters and inflation targeters is largely due to a significantly worse performance by emerging economies. Emerging inflation targeters (both converging and stationary) not only exhibit larger supply shocks, but are also further away from their efficiency frontiers (figure 23). However, the large difference between nontargeters and all emerging inflation targeters (ΔL equals –6.086; row 4c), declines by half once emerging inflation targeters attain stationary inflation targets (ΔL is –2.976; row 5c).

Industrial inflation targeters are much closer in performance to our control group of nontargeters, and the difference narrows further when we compare stationary industrial inflation targeters to nontargeters (row 5b and figure 25). The relatively small difference in performance (ΔL is –0.787) is due mainly to the supply shocks faced by industrial stationary inflation targeters (explaining 67.5 percent of the difference) and less to less efficient policy (explaining 32.5 percent of the difference).

Based on the evidence in this section, we conclude that countries adopting inflation targeting have substantially improved the efficiency of their monetary policy. Furthermore, the gains in efficiency are larger for stationary inflation targeters than for inflation targeters in general. Relevant differences in performance levels and gains are apparent when disaggregating inflation targeters into industrial and emerging economies. Observed macroeconomic performance is much better in industrial inflation targeters than in emerging inflation targeters both before and after the adoption of inflation targeting (or stationary inflation targeting). However, the improvement that comes with the adoption of inflation targeting is much larger in emerging economies than in industrial countries. Convergence toward stationary inflation targeting is particularly beneficial to emerging economies. These countries record major reductions in output and inflation volatility after adopting stationary inflation targeting, both because they face smaller supply shocks and because they improve their monetary policy efficiency. In contrast, industrial inflation targeters improve their macroeconomic performance only because they face smaller supply shocks; their monetary policy efficiency levels (which were already high before the adoption of inflation targeting, compared with emerging countries) actually deteriorate somewhat after the adoption of inflation targeting.

The likely source of the overall macroeconomic improvement that comes with inflation targeting is the credibility that inflation targeters gain when they finally achieve sufficient disinflation to stabilize their inflation targets. Increased credibility helps shift monetary policy outcomes closer to the efficiency frontier. This is particularly the case of emerging countries, where the pre-targeting gap between actual and desirable macroeconomic performance is the largest and where pre-targeting credibility is weak.

Although inflation targeting improves monetary performance over time, our control group of nontargeters still exhibits better macroeconomic performance and higher levels of monetary policy efficiency than our different treatment groups of inflation targeters. The differences between industrial nontargeters and emerging inflation targeters have narrowed massively under inflation targeting, but they remain large. Nontargeters also display better macroeconomic performance than industrial inflation targeters, but this difference is small and has narrowed under inflation targeting. Most of the remaining performance differences between industrial inflation targeters and nontargeters—in favor of the latter—stems from the smaller supply shocks faced by nontargeters, while monetary policy is only marginally more efficient in nontargeters than in industrial inflation targeters.

5. Inflation Accuracy

How accurate are inflation-targeting central banks in hitting their official targets? And how does their accuracy compare to the success of nontargeting countries in achieving a stable inflation rate? The first question is addressed by Calderón and Schmidt-Hebbel (2003), Albagli and Schmidt-Hebbel (2005), and Roger and Stone (2005). The first two of these studies also identify the determinants of success in hitting inflation targets, showing that institutional variables (such as central bank independence) and credibility measures (including investment risk measures and country risk spreads) are significant factors in reducing target misses among inflation targeters.

We address the second question in this section. Our results are tentative because they involve comparing easily measured deviations of actual inflation from target levels in inflation-targeting countries with the deviations of actual inflation from inflation objectives in nontargeting countries, which are not easily measured since they are not announced in nontargeting countries. We construct proxies for implicit inflation objectives in the form of inflation trends obtained using the Hodrick-Prescott filter. These proxies are likely to underestimate the true measures of inflation deviations in nontargeting countries because the HP-filtered trend could react excessively to temporary inflation deviations. The size of the potential bias is likely to be inversely correlated with the degree of smoothing applied by the HP filter. We therefore conduct robustness tests of our results along two dimensions: the assumption about inflation deviations in inflation-targeting countries and the degree of HP smoothing of the actual inflation series.

For the first dimension, we compute two measures of inflation deviations for inflation-targeting countries. The first inflation deviation measure (ID1) computes the deviation of actual inflation from actual inflation targets, while the second inflation deviation measure (ID2) provides the deviation of actual inflation from HP trends for inflation-targeting countries, to maximize comparability with our measure of inflation deviation for nontargeting countries. All measures are absolute values of inflation deviations.

We report on both measures for several country groups and for the full 1989—2004 period and subperiods in table 10 and figure 27. For ID1, the median absolute inflation deviation is 1.03 percent for inflation targeters and 0.54 percent for nontargeters. For ID2, the median absolute inflation deviation is lower for inflation targeters, at 0.84 percent, and unchanged for nontargeters, at 0.54 percent. The inflation deviation measure based on actual inflation targets (ID1) for inflation targeters is systematically larger than the one based on HP-filtered inflation trends (ID2) across all subgroups of inflation-targeting countries. This suggests that the use of HP-filtered inflation trends as a proxy for implicit inflation objectives for nontargeters and for inflation targeters during the pre-targeting period may, in fact, bias downward the inflation deviation measures in inflation targeters and thus bias upward the reported differences of deviations between inflation targeters and nontargeters.

Table 10: Absolute Deviation of the Inflation Rate from Target or Trend in Inflation Targeters and Nontargeters[a]

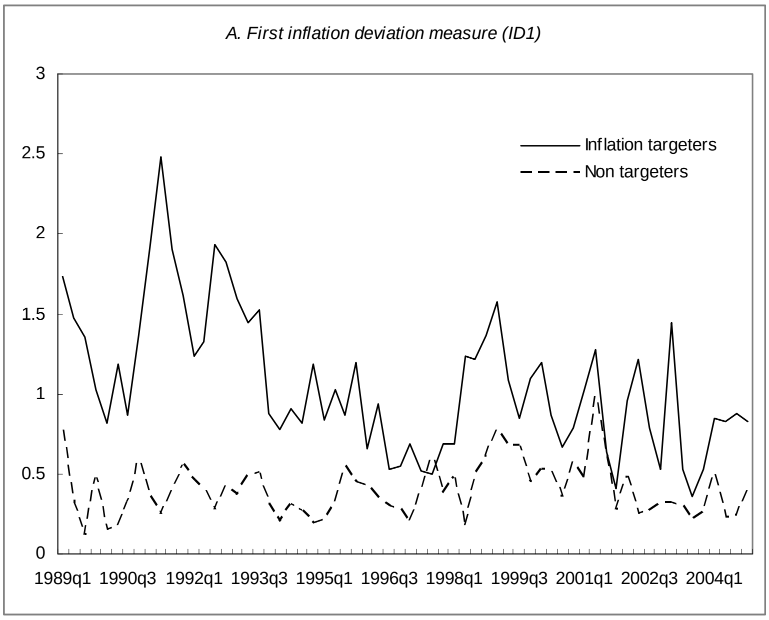
	ID1			ID2		
	Percentile			*Percentile*		
Sample group	*25*	*50*	*75*	*25*	*50*	*75*
Inflation Targeters	0.46	1.03	1.99	0.33	0.84	1.74
Industrial Economies (7)	0.40	0.77	1.39	0.23	0.50	1.13
Emerging Economies (14)	0.49	1.28	2.42	0.50	1.14	2.00
Stationary (16)	0.38	0.77	1.46	0.24	0.56	1.16
Converging (14)	0.63	1.49	2.77	0.70	1.42	2.17
Nontargeters	0.24	0.54	1.20	0.24	0.54	1.20
Always nontargeters (13)	0.18	0.36	0.67	0.18	0.36	0.67
Targeters before targeting (21)	0.41	1.12	2.38	0.41	1.12	2.38

Source: Author's calculations, based on data from Organization for Economic Cooperation and Development, *Main Economic Indicators*; IMF; and central banks.

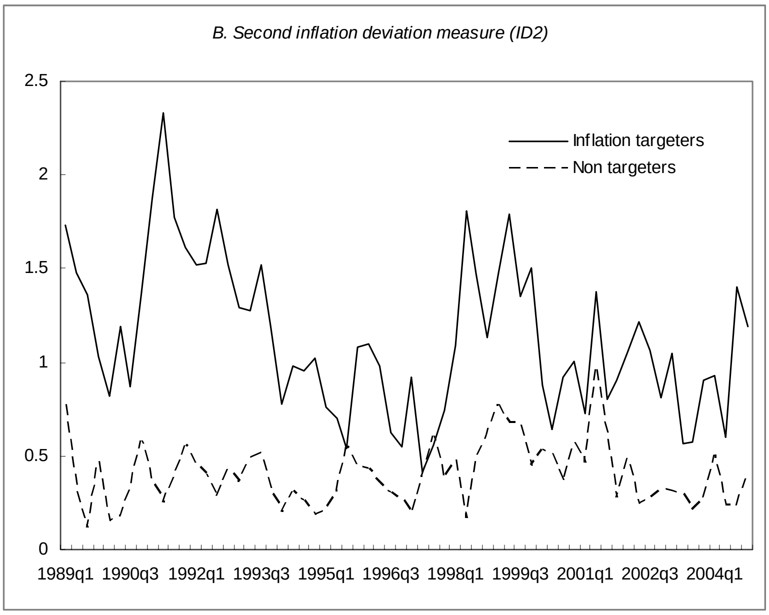
a. For inflation-targeting countries, ID1 is defined as the absolute deviation of actual inflation from inflation targets, and ID2 is the absolute deviation of actual inflation from its HP trend. For nontargeting countries, ID1 and ID2 are defined as the absolute deviation of actual inflation from its HP trend. Number of countries is in parentheses.

Figure 27: Median Absolute Deviations of Inflation Rate from Inflation Target or from Trend in Inflation Targeters and Nontargeters, 1989–2004[a]

A. First inflation deviation measure (ID1)



B. Second inflation deviation measure (ID1)



Source: Author's calculations, based on data from Organization for Economic Cooperation and Development, *Main Economic Indicators*; IMF; and central banks.
a. See the text for definitions of inflation deviation measures ID1 and ID2.

Figure 27 depicts the time pattern of median absolute inflation deviations for inflation targeters and nontargeters, using both measures. Nontargeters exhibit systematically lower inflation deviations than inflation targeters. However, inflation targeters' median inflation deviations show a negative trend in 1989–2004, whereas the median inflation deviations of nontargeters are stationary.[20]

Our subsamples of inflation targeters display large differences in hitting targets. According to the ID1 measure, the median absolute inflation deviation is 0.77 percent in industrial economies, versus 1.28 percent in emerging economies (table 10). The difference is even larger when we divide inflation targeting experiences according to periods of converging targets, when median absolute inflation deviations are 1.49 percent, and stationary targets, when deviations decline by half to reach 0.77 percent. As expected, the largest difference is observed between two very heterogeneous nontargeting experiences: before the adoption of inflation targeting (or before 1997 for nontargeters), median absolute inflation deviations were 1.12 percent among inflation targeters and 0.36 percent among nontargeters.

However, the latter prima facie evidence of poorer inflation accuracy in inflation-targeting countries is far from conclusive. Many large inflation-target misses could be explained by idiosyncratic country or time-period shocks, and these could be correlated with the adoption of inflation targeting, particularly in emerging economies. We thus test for significant differences in inflation deviations between inflation targeters and nontargeters, controlling for potential determinants of inflation shocks.

[20] We reject the presence of nonstationarity in all series at the 1 percent confidence level using the augmented Dickey-Fuller and Phillips-Perron unit root tests.

Following previous work on differences in inflation deviations among inflation targeters (Calderón and Schmidt-Hebbel, 2003; Albagli and Schmidt-Hebbel, 2005), we specify the following panel data specification for the absolute value of deviations of inflation ($|\pi_{i,t} - \pi^*_{i,t}|$):

$$\left|\pi_{i,t} - \pi^*_{i,t}\right| = \sum_{j=1}^{r} \phi_j \left|\pi_{i,t} - \pi^*_{i,t}\right| + \alpha \mathrm{IT}_{i,t} + \mathbf{X}_{i,t}\beta + c_i + e_{i,t}\,, \qquad (13)$$

as a function of its own lag, a vector of relevant inflation-shock controls ($\mathbf{X}_{it}$), a dummy variable (IT_{it}) that takes a value of one if the country has an inflation-targeting regime in place and zero otherwise, and country- and time-specific effects. The inflation deviation is defined as the absolute value of the difference between the twelve-month CPI inflation rate ($\pi_{i,t}$) and the annual inflation target ($\pi^*_{i,t}$). The vector of control variables comprises two domestic shocks (absolute nominal exchange rate shocks and the output gap or the absolute deviation of output growth from trend) and two external shocks (the lagged absolute deviation of the Federal funds rate from trend and the absolute deviation of the international oil price from trend).

We estimate our model for absolute inflation deviations in equation 13 using an unbalanced panel sample of twenty-one inflation-targeting and twelve nontargeting countries, with quarterly observations for 1989–2004.[21] As in preceding sections, we consider two alternative control groups: control group 1 includes the full nontargeting sample of both industrial nontargeting countries and the pre-targeting observations of all subsequent inflation targeters, while control group 2 encompasses only the industrial nontargeting countries. Furthermore, we control for possible endogeneity of the choice of the inflation-targeting regime (the inflation-targeting dummy variable) and the two domestic shocks, using as instruments the variables listed at the bottom of tables 11 and 12 and making use of panel data IV estimation. For control group 1, we obtain the fixed-effects estimator, but we are unable to estimate a fixed-effects model for control group 2 owing to the presence of time-invariant variables. To tackle this problem, we follow Plümper and Troeger (2004), who obtain a modified Hausman-Taylor IV estimator to compute the coefficients of time-invariant variables.[22]

[21] To avoid endogeneity problems with the Federal funds rate variable, we excluded the United States from our standard control group of thirteen nontargeting countries.

[22] This procedure can be summarized in three steps. First, we estimate a panel fixed-effects model excluding time-invariant right-hand-side variables. Second, we regress the fixed-effects vector on the time-invariant explanatory variables and obtain its unexplained part. Finally, we estimate a pooled IV model including all explanatory time-variant and time-invariant variables, as well as the unexplained part of the fixed-effects vector. Using Monte Carlo experiments, Plümper and Troeger (2004) find that their estimation technique performs better than pooled OLS and random-effects models in the estimation of the coefficients of time-invariant variables.

Table 11: Inflation Deviation from Target or Trend in Targeting and Nontargeting Countries: ID1[a]

Explanatory variable	**Control group 1** (1)	**Control group 2** (2)	**Control group 1** (3)	**Control group 2** (4)	**Control group 1** (5)
Abs [Deviation from target (*t*–1)]	0.537	0.490	0.537	0.511	0.537
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Inflation-targeting dummy	–0.181	–0.447			
	(0.063)*	(0.275)			
Abs [NER depreciation]	0.047	0.013	0.048	0.021	0.047
	(0.000)***	(0.039)**	(0.000)***	(0.007)***	(0.000)***
Abs [Output gap (*t*–1)]	0.033	0.035	0.038	0.075	0.029
	(0.443)	(0.393)	(0.394)	(0.245)	(0.503)
Abs [Oil gap]	0.003	0.002	0.003	0.002	0.003
	(0.069)*	(0.123)	(0.075)*	(0.192)	(0.062)*
Abs [Fed funds rate (*t*–4)]	0.033	0.020	0.035	0.030	0.034
	(0.014)**	(0.197)	(0.009)***	(0.063)*	(0.011)**
Stationary targeters			–0.133	–0.348	
			(0.257)	(0.489)	
Converging targeters			–0.232	–0.118	
			(0.065)*	(0.924)	
Emerging targeters					–0.245
					(0.039)**
Industrial targeters					–0.077
					(0.610)
Constant	–0.105	1.063	–0.123	0.629	–0.111
	(0.358)	(0.012)**	(0.288)	(0.496)	(0.333)
No. observations	1861	1375	1865	1391	1861
No. countries	33	33	33	33	33

Source: Author's estimations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. The dependent variable is absolute inflation deviation, given by our ID1 measure. For inflation-targeting countries, ID1 is defined as the absolute deviation of actual inflation from inflation targets; for nontargeting countries, ID1 is defined as the absolute deviation of actual inflation from its HP trend. The regressions are based on panel IV estimations. The instrument set includes lagged values of inflation deviation from target, an inflation-targeting dummy, nominal exchange rate depreciation, the output gap, and contemporaneous observations of the oil gap and the Federal funds rate. Control group 1 includes all nontargeters and pre-targeters; control group 2 includes only all nontargeters. *P* values are reported in parentheses.

Table 12: Inflation Deviation from Target or Trend in Targeting and Nontargeting Countries: ID2[a]

Explanatory variable	**Control group 1** *(1)*	**Control group 2** *(2)*	**Control group 1** *(3)*	**Control group 2** *(4)*	**Control group 1** *(5)*
Abs [Deviation from target (*t*–1)]	0.527	0.502	0.528	0.451	0.527
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Inflation-targeting dummy	–0.270	–0.205			
	(0.002)***	(0.668)			
Abs [NER depreciation]	0.038	0.005	0.038	0.007	0.038
	(0.000)***	(0.309)	(0.000)***	(0.212)	(0.000)***
Abs [Output gap (*t*–1)]	0.091	0.121	0.091	0.134	0.091
	(0.021)**	(0.002)***	(0.026)**	(0.005)***	(0.023)**
Abs [Oil gap]	0.003	0.002	0.003	0.002	0.003
	(0.033)**	(0.078)*	(0.033)**	(0.133)	(0.032)**
Abs [Fed funds rate (*t*–4)]	0.026	0.005	0.026	0.010	0.026
	(0.034)**	(0.716)	(0.031)**		(0.033)**
Stationary targeters			–0.264	–0.408	
			(0.012)**	(0.408)	
Converging targeters			–0.258	–0.121	
			(0.023)**	(0.907)	
Emerging targeters					–0.280
					(0.008)***
Industrial targeters					–0.252
					(0.061)*
Constant	–0.051	0.684	–0.060	0.730	–0.052
	(0.615)	(0.177)	(0.562)	(0.390)	(0.608)
No. observations	1861	1390	1865	1391	1861
No. country	33	33	33	33	33

Source: Author’s estimations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. The dependent variable is absolute inflation deviation, given by our ID2 measure. For both inflation-targeting and nontargeting countries, ID2 is defined as the absolute deviation of actual inflation from its HP trend. The regressions are based on panel IV estimations. The instrument set includes lagged values of inflation deviation from target, an inflation-targeting dummy, nominal exchange rate depreciation, the output gap, and contemporaneous observations of the oil gap and the Federal funds rate. Control group 1 includes all nontargeters and pre-targeters; control group 2 includes only all nontargeters. *P* values are reported in parentheses.

The results are reported in table 11 (using the ID1 measure as the dependent variable) and table 12 (using the ID2 measure as the dependent variable). Each table presents results for the two alternative nontargeting control groups and for alternative inflation-targeting dummies (one for all inflation-targeting country experiences and others that capture a heterogeneous effect of inflation targeting for converging and stationary inflation-targeting periods and for emerging and industrial inflation-targeting countries).

Inflation deviations exhibit systematic persistence, as reflected by the significant coefficient of the lagged dependent variable. Its point estimate is close to 0.5 across the ten results reported in tables 11 and 12, which shows that the long-term effects of all other variables are close to twice their contemporaneous effects. All control variables exhibit the expected positive signs, and most are significant at conventional levels.

Our variable of interest—namely, the inflation-targeting dummy—exhibits a robust negative coefficient across all regressions, but it is only significant when we use the first control group. For example, the first column of table 11 reports that the contemporaneous effect of inflation targeting is to reduce absolute inflation deviations by 0.18 percent, when using the ID1 measure and the full sample of nontargeting country experiences (control group 1). Moreover, the contemporaneous impact of inflation targeting on absolute inflation deviations rises in magnitude from –0.18 to a long-term effect of –0.40 percent, that is, 0.18 percent / (1–0.54). The effect of inflation targeting increases to –0.45 percent, but it is insignificant when we exclude pre-targeting experiences in inflation-targeting countries (column 2). The latter result is the relevant one for comparing inflation-targeting experiences to those of countries that never had inflation targeting in place.

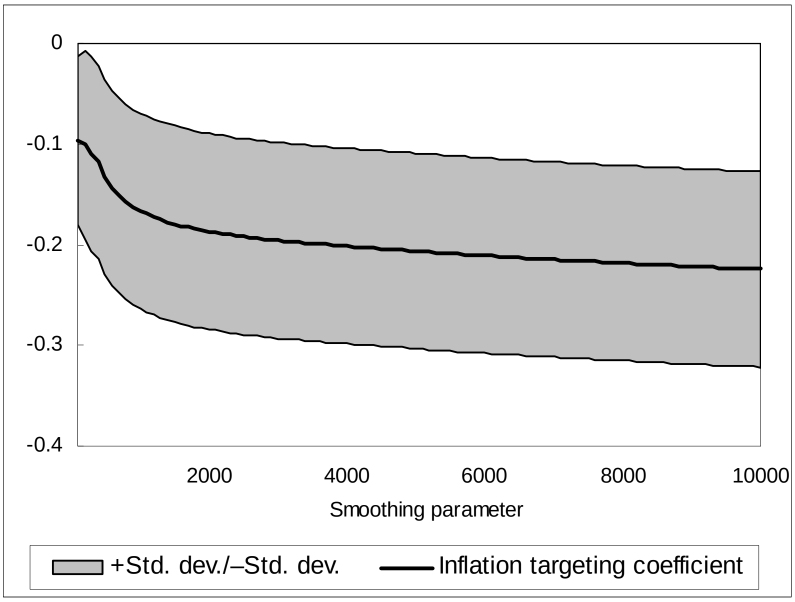
The result in column 1, based on ID1, increases to –0.27 percent when we use the ID2 measure, as reported in column 1 of table 12. This confirms that inflation target deviations from actual targets lead to higher deviations than those measured as deviations from HP-filtered trends. It suggests that comparing actual deviations from observable targets in inflation-targeting countries with HP-filter-inferred deviations from unobservable inflation objectives in nontargeting countries leads to an upward bias in inflation targeters' deviations relative to nontargeters' deviations. The reported coefficients for the inflation-targeting regime based on the ID1 measures are thus likely to be lower-bound estimates, while those based on the ID2 measure might be closer to the unobservable regime difference.

Columns 3, 4, and 5 in tables 11 and 12 report coefficients for separate inflation-targeting dummy variables for converging-target and stationary-target inflation-targeting periods and for emerging and industrial inflation targeters. For both cases, the coefficients exhibit the expected negative sign, but they vary in significance and magnitude. The results in column 3 show that converging inflation targeters exhibit about 0.24 percent lower absolute deviations of inflation, while the results for stationary inflation targeters vary from –0.13 percent to –0.26 percent. When we restrict the control group to the nontargeting countries that never had inflation targeting in place, the results remain negative but lose statistical significance (see column 4). Column 5 presents the coefficients that capture separate effects of inflation targeting on emerging and industrial economies. Only emerging countries show a significantly lower inflation deviation than that observed in control group 1. When we use the ID2 measure, however, the results suggest that both emerging and industrial inflation targeters observe lower absolute inflation deviations (of similar magnitude) than those observed in control group 1.

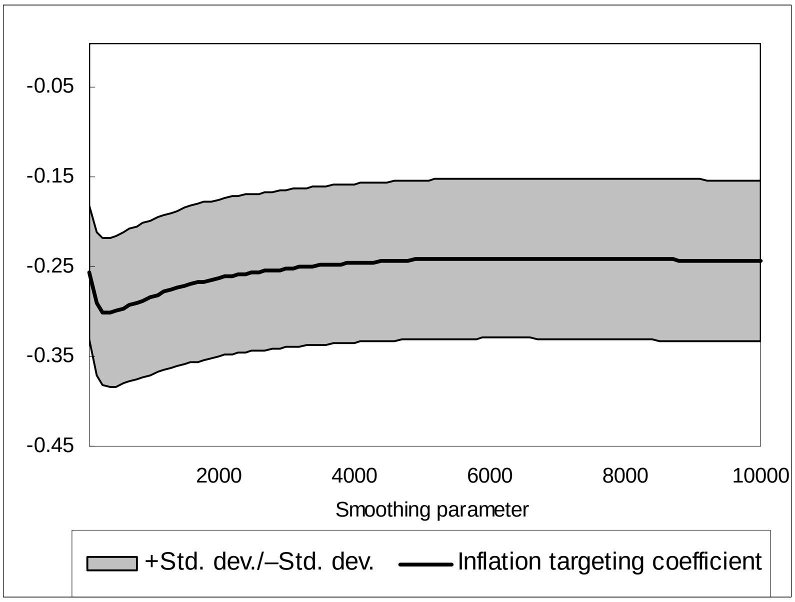
To check the robustness of our results to the underlying assumptions on the Hodrick-Prescott filtering procedure to obtain inflation trends as proxies for inflation objectives, we ran the regressions reported in column 1 of tables 11 and 12 on alternative absolute inflation deviation series based on different values of the HP filter smoothing parameter used in obtaining trend inflation series.[23] Figure 28 depicts the estimated coefficient of the inflation-targeting dummy variable for alternative smoothing parameter values ranging from 100 to 10,000. The figure suggests that the inflation-targeting coefficient estimates of –0.18 and –0.27 in column 1 of tables 11 and 12 are robust to wide ranges of alternative HP smoothing parameters.

Figure 28: Estimated Coefficient of Inflation Targeting for Alternative Values of the HP Filter Smoothing Parameter[a]

A. First inflation deviation measure (ID1)



B. Second inflation deviation measure (ID1)



Source: Author's estimations.

a. The reported coefficients correspond to the IT dummy coefficients from the regressions reported in column 1 of tables 11 and 12.

23) The coefficient used in all HP-filtered trends discussed in this paper is the standard lambda equal to 1,600 for quarterly data.

We conclude the following from the results reported in this section. Prima facie, inflation deviations from inflation targets or trends are larger in inflation-targeting than in nontargeting countries. However, this evidence is based on simple sample statistics that do not control for country- and time-specific shocks that affect inflation deviations and that could be correlated with inflation-targeting experiences (across countries and over time). When we control for the latter shocks, our econometric findings point toward a much more differentiated performance regarding inflation accuracy under inflation targeting. First, when comparing all inflation targeters (and also the emerging/industrial and converging/stationary subsamples) to all nontargeting experiences (including nontargeting countries and pre-targeting experiences, represented by control group 1), inflation deviations are smaller in inflation-targeting than in nontargeting countries. The point estimates for the inflation-targeting gain in inflation deviations ranges from 0.18 percent to 0.45 percent (and roughly twice the latter range for the long-term inflation-targeting gain) for the full experience of inflation-targeting countries and periods. However, this result is not robust to using the alternative control group 2, comprising only nontargeting countries. While inflation deviations are still smaller in inflation-targeting countries, the corresponding coefficients are no longer significantly different from zero. When we use our preferred inflation deviation measure, ID2, and disaggregate all inflation targeters into different subgroups, we find that inflation targeting lowers absolute inflation deviations by similar amounts in emerging and industrial targeters and in converging and stationary targeters.

6. Conclusions

A steadily growing number of industrial and emerging countries have explicitly adopted an inflation target as their nominal anchor. Eight industrial countries and thirteen emerging economies had full-fledged inflation targeting in place in early 2005. Many other emerging economies are planning to adopt inflation targeting in the near future. This paper has explored whether inflation targeting makes a difference after central banks adopt the regime as an explicit and exclusive anchor for conducting monetary policy.

Previous empirical evidence on the direct link between inflation targeting and particular measures of economic performance provides some support for the view that inflation targeting is associated with an improvement in overall economic performance. However, the ongoing debate on whether inflation targeting matters indicates that open questions remain, particularly on the comparative macroeconomic performance in inflation targeting countries, both over time and relative to nontargeting countries. Are inflation levels and inflation and output volatilities lower in inflation-targeting countries? Do monetary policy and macroeconomic performance variables respond differently to shocks under inflation targeting? Is monetary policy more efficient under inflation targeting? Are inflation-targeting central banks more accurate in hitting their targets than nontargeting countries are in maintaining or achieving stable inflation?

We have addressed these questions by systematically applying a common methodological approach, across issues and throughout the paper. We have looked for empirical evidence in the world sample of twenty-one industrial and emerging-economy inflation-targeting countries, before and after their adoption of inflation targeting, and compared their performance to a control group of thirteen industrial nontargeters. We have distinguished between two types of inflation-targeting regimes, one in which inflation targets are still converging to the long-run goal for inflation and one in which the inflation target is stationary. We have tested for differences in group behavior of inflation targeters and nontargeters and for changes between pre- and post-targeting changes among inflation targeters, making statistical inferences from panel data estimations, panel vector autoregressive models, and panel impulse responses. Finally, to exploit the rich available data and identify dynamic patterns, we have used a high-frequency sample of quarterly data, covering 1989–2004 and subperiods.

Comparative descriptive statistics on inflation performance confirm that inflation targeters reduced their average inflation rates from 12.6 percent before the adoption of inflation targeting to 4.4 percent thereafter. Inflation declined to 6.0 percent in the post-adoption convergence period and then to 2.3 percent after the achievement of stationary targets. Emerging-economy inflation targeters recorded an average 6.0 percent inflation after they adopted inflation targeting, while the corresponding figure is only 2.2 percent for industrial-economy inflation targeters. The latter figure is very close to the average 2.1 percent inflation recorded among nontargeters since 1997. A similar pattern is observed for inflation volatility. Inflation volatility in industrial inflation targeters is twice the level recorded in nontargeters, but inflation persistence is slightly lower in industrial inflation targeters than in nontargeters. Emerging inflation targeters, in turn, achieved a significant reduction in output growth volatility and output gap volatility under inflation targeting. Nontargeters also achieved a significant reduction in both volatility measures after 1997, to levels that are below those recorded by industrial inflation targeters. However, output persistence, like inflation persistence, is lower in stationary-target inflation targeters than in nontargeters.

Moving beyond unconditional inflation comparison, we follow previous research by testing for systematic differences in inflation levels between inflation-targeting and nontargeting countries, controlling for past inflation. The evidence on the comparative inflation performance of inflation targeters and nontargeters reported both here and in the previous literature shows that the effect of inflation targeting on inflation can go either way. Our findings suggest that the source of such differences lies in the use of heterogeneous control groups. The absence of panel data techniques in the earlier literature prevents the disaggregation of control groups across countries and time.

We have extended the earlier research, exploiting both the cross-section and time dimensions of our sample. We find that the largest difference in inflation performance is observed when the treatment group is compared to its own pre-targeting experience. When nontargeting countries are added to the control group, this effect declines but is still statistically significant. However, when we restrict the control group to nontargeting countries, we find no systematic, significant difference in inflation between inflation targeters and nontargeters. Further disaggregation of the treatment group into industrial and emerging inflation targeters and into converging-target and stationary-target inflation targeters yields mixed results. They confirm that results are highly dependent on the choice of control groups. They also suggest that emerging-economy and converging-target inflation targeters record the largest gains in inflation reduction. Industrial inflation targeters exhibit a statistically weak reduction in inflation in comparison with industrial nontargeting countries.

If inflation targeting improves the credibility of monetary policy and strengthens the anchoring of inflation expectations, we would expect inflation targeting to reduce inflation’s response to oil price shocks and lessen the pass-through effect from exchange rate shocks. As a result of increased credibility and reduced devaluation to inflation pass-through, inflation targeting may also strengthen monetary policy independence (that is, weaken the reaction of domestic interest rates to foreign interest rate shocks). We have therefore assessed whether inflation targeters differ from nontargeters—and whether post-targeting differs from pre-targeting among inflation targeters—in the response of inflation to shocks in oil prices and the exchange rate and the response of domestic interest rates to innovations in international interest rates. Our results are as follows.

We reach two conclusions on the inflation consequence of oil price shocks. First, inflation targeting helps all inflation targeters reduce the domestic inflation response to an oil price shock relative to their own pre-targeting experience, although this reduction is not statistically different from zero. Second, in all inflation-targeting treatment groups, the inflation response to oil price shocks is smaller than in nontargeting countries after 1997. The difference in favor of inflation targeters is statistically significant, on average, for later quarters, because the effects of an oil shock on domestic inflation are smaller and less persistent in inflation-targeting countries than in nontargeters. Surprisingly, this result is particularly strong in emerging-market stationary-target inflation targeters, where the response of inflation to the oil price is the smallest and least persistent.

We also present two conclusions based on our comparison of the dynamics of the pass-through effects from exchange rate shocks to domestic inflation. First, the adoption of inflation targeting helped reduce the short-term pass-through under stationary-target inflation targeting, vis-à-vis their own pre-targeting experience. This result, however, is entirely driven by emerging-market inflation targeters, where pass-through coefficients fell somewhat after a stationary target was achieved but remained positive and significantly different from zero. In industrial inflation targeters and nontargeters, the pass-through effects were close to zero before and after inflation targeting (or before and after 1997, in the case of nontargeters). Second, when we compare all inflation targeters and all stationary inflation targeters to nontargeters after 1997, the pass-through coefficients are significantly larger in the former groups than in the latter. This result is due to emerging-market inflation targeters, which exhibit much larger pass-through coefficients than nontargeters after 1997; the differences are statistically significant from quarters 1 through 5, on average. In contrast, industrial inflation targeters and nontargeters do not exhibit any significant differences in pass-through performance.

To measure monetary independence, we compared the dynamic responses of domestic interest rates to a shock in the international interest rate, and we again arrived at two conclusions. First, the adoption of inflation targeting has brought down interest sensitivity estimates for the full group of inflation-targeting countries. This aggregate result hides two opposing changes, however. The adoption of inflation targeting in industrial countries has increased interest rate sensitivity from negative to positive and significant. In contrast, in emerging-market inflation targeters, interest sensitivity has declined from huge before inflation targeting to moderate during converging-target inflation targeting and to small under stationary-target inflation targeting. Second, these changes made inflation targeters more similar to nontargeters. While interest rate sensitivity to foreign rate shocks is slightly larger in industrial stationary inflation targeters than in nontargeters and slightly smaller in emerging-market stationary inflation targeters than in nontargeters, the differences are not statistically significant. Our measures of monetary independence thus reveal a convergence of inflation-targeting countries that have achieved stationary targets to the levels exhibited by nontargeters.

Next we investigated the potential gains associated with inflation targeting in terms of improving macroeconomic performance (that is, the reduction in inflation and output volatilities), which can be attributed to smaller supply shocks and more efficient monetary policy. The comparative results for inflation-targeting countries over time (that is, before and after the adoption of inflation targeting) and relative to nontargeting countries are as follows. Adopting inflation targeting led to substantial improvement in the efficiency of monetary policy; these gains are larger for stationary inflation targeters than for inflation targeters in general. Observed macroeconomic performance is much better in industrial inflation targeters than in emerging inflation targeters, both before and after the adoption of inflation targeting (or stationary inflation targeting). However, emerging economies recorded a much greater improvement following the adoption of inflation targeting than industrial countries. Emerging economies registered major reductions in output and inflation volatility after adopting stationary inflation targeting, both because they faced smaller supply shocks and because they improved their monetary policy efficiency. In contrast to emerging inflation targeters, industrial targeters improved their macroeconomic performance only because they faced smaller supply shocks; their monetary policy efficiency levels (which were already high before the adoption of inflation targeting, compared with emerging countries) actually deteriorated somewhat after the adoption of inflation targeting.

Although inflation targeting improves monetary performance over time, our control group of nontargeters still exhibits better macroeconomic performance and higher levels of monetary policy efficiency than our different treatment groups of inflation targeters. The differences between industrial nontargeters and emerging inflation targeters narrowed massively under inflation targeting, but they still remain large after the achievement of stationary inflation targeting. Nontargeters also exhibited better macroeconomic performance than industrial inflation targeters, but this difference was small and narrowed under inflation targeting. Most of the remaining performance difference between industrial inflation targeters and nontargeters—in favor of the latter—is explained by the smaller supply shocks faced by nontargeters, while monetary policy efficiency is only marginally better in nontargeters than in industrial inflation targeters.

We ended our research by comparing the success of inflation-targeting central banks in hitting their official targets (or maintaining inflation levels close to their inflation trends) to the success of nontargeting central banks in maintaining inflation levels close to their inflation trends. Prima facie, inflation deviations from inflation targets or trends are larger in inflation-targeting than in nontargeting countries. However, this evidence is based on simple sample statistics that do not control for country- and time-specific shocks that affect inflation deviations and that could be correlated with inflation-targeting experiences (across countries and over time). When we control for such shocks, our findings point to a more differentiated performance regarding inflation accuracy under inflation targeting. First, when comparing the full sample of inflation targeters (and also the emerging/industrial and converging/stationary subsamples) to all nontargeting experiences (including nontargeting countries and pre-targeting experiences), inflation deviations are significantly smaller in inflation-targeting than in nontargeting experiences. This result is not robust, however, when the control group includes only nontargeting countries. Inflation deviations are still numerically smaller in inflation-targeting countries relative to nontargeting countries, but the differences are not statistically significant from zero. This holds for both the aggregate treatment group comprising all inflation targeters and the different inflation-targeting subgroups (emerging and industrial targeters and converging and stationary targeters): inflation deviations are numerically lower than in nontargeting countries, but the difference is not statistically significant.

We conclude that our evidence supports inflation targeting. Inflation targeting seems to help countries achieve lower inflation in the long run, reduce their response to oil price and exchange rate shocks, strengthen monetary policy independence, improve monetary policy efficiency, and obtain inflation outcomes that are closer to target levels. Furthermore, some benefits of inflation targeting increase when inflation targeters achieve disinflation and are able to implement a stationary inflation target. This may suggest that the credibility of an inflation-targeting regime improves once it becomes a stationary regime.

Inflation targeting thus seems to be the natural monetary regime choice, especially for emerging-market economies, where the gains from inflation targeting are found to be the largest. Not surprisingly, a large number of developing countries are currently planning to adopt inflation targeting in the near future.

Despite the favorable results attained by inflation-targeting countries over time, our evidence generally does not suggest that countries that adopt inflation targeting have improved their monetary policy performance beyond that of our control group of nontargeters, all of which are industrial countries with a successful monetary policy. However, inflation targeting does seem to help countries converge toward the performance of our very demanding control group, particularly during the mature phase of stationary targeting.

Indeed, obtaining a strong nominal anchor is the key to successful monetary policy. Our evidence suggests that some industrial countries have been able to obtain a strong nominal anchor without resorting to inflation targeting. The Federal Reserve's policies under Alan Greenspan, for example, may not have been very different or any better if the Federal Reserve had adopted inflation targeting (Mishkin, 2005). It is therefore not entirely surprising that we did not find much evidence that inflation targeters do better than our control group of industrialized nontargeters.

Nevertheless, we feel that the adoption of inflation targeting has advantages even for industrial countries. Industrialized countries that have not adopted inflation targeting face four problems (see Bernanke and others, 1999; Mishkin, 2005). First, the strong nominal anchor that produced a successful monetary policy is often based on individuals, and their replacements may not be strongly committed to the nominal anchor. Second, the focus on the long run exhibited by successful nontargeters may weaken in the future. Third, the lack of transparency about the goals of monetary policy increases uncertainty. Fourth, the lack of accountability in the absence of inflation targeting could undermine central bank independence in the future, thereby weakening the nominal anchor. Inflation targeting has the potential to ensure that the successful monetary policy performance of our control group of industrial nontargeters in recent years continues in the future.

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