Does Inflation Targeting Make a Difference? *

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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 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 does not suggest that countries that adopt inflation targeting have attained better monetary policy performance relative to our control group of successful non-inflation targeters. However, inflation targeting does seem to help countries converge toward the performance of the control group. The one exception to the generally better performance of the control group is the attainment of inflation targets or objectives. Controlling for exogenous inflation shocks, we report tentative evidence that inflation targeters are more successful than non-targeters in reducing inflation deviations from inflation trends – a likely result of the stronger, explicit focus on inflation control among inflation-targeting central banks.

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1. Introduction: What is the State of the Debate

Since the adoption by New Zealand in 1990, a steadily growing number of industrial and emerging-economy countries have adopted explicitly an inflation target as their nominal anchor. Eight industrial countries and 13 emerging economies had full-fledged inflation targeting (IT) in place in early 2005. Many other emerging economies are planning to adopt inflation targeting in the near future.

An intensifying debate is taking place regarding the question in the title of this paper: Does inflation targeting make a difference? In other words, are central banks better off with adopting inflation (forecast) targeting as an explicit and exclusive anchor for conducting monetary policy? Is there hard evidence for better macroeconomic performance under IT, in comparison to countries without explicit inflation targeting? What is the current state of the debate on whether inflation targeting is able to improve economic performance?

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]

1. Inflation levels (and volatility), as well as interest rates, have declined after countries adopted inflation targeting.
2. Output volatility has not worsened, and if anything improved, after adoption of inflation targeting.
3. Exchange rate pass-through seems to be attenuated by adoption of inflation targeting.
4. 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 non-inflation targeting industrialized countries such as the United States or Germany.[3]

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[1] This is the conclusion in a recent paper presented to the Executive Board of the IMF, Roger and Stone (2005).

[2] There is also some mildly favorable evidence on the impact of inflation targeting on sacrifice ratios. Bernanke et al. (1999) did not find that sacrifice ratios in industrialized countries fell with adoption of inflation targeting, while Corbo, Landerretche and Schmidt-Hebbel (2002) with a larger sample of inflation targeters have concluded that inflation target 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 rather than nominal shocks. This might indicate that inflation targeting can help the nominal exchange rate to act as a shock absorber for the real economy.

[3] For evidence supporting the first four results, see e.g. Bernanke et. al. (1999), Corbo, Landerretche and Schmidt-Hebbel (2002), Neumann and von Hagen (2002), Hu (2003), Truman (2003), and Ball and Sheridan (2005).

Although these results suggest that inflation targeting is beneficial, they are less conclusive than at first appears. Ball and Sheridan (2005), one of the few empirical papers critical of inflation targeting, argue that inflation targeting does not make a difference in industrial countries. They argue that the apparent success of inflation targeting countries is just a reflection of regression towards the mean: that is, countries that start with higher inflation are more likely to find that inflation will fall faster than countries that start with an initially low inflation rate. Since countries that adopted inflation targeting generally had higher initial inflation rates, their larger decline in inflation just reflects a general tendency of all countries, both targeters and non-targeters to achieve better inflation and output performance in the 1990s when inflation targeting was adopted.

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

The fourth result that inflation and output performance of inflation targeting countries improves but is no better than that of countries like the United States and Germany also suggests that what is really important to successful monetary policy is establishment of a strong nominal anchor. As pointed out in Bernanke and Mishkin (1992), Mishkin and Posen (1997), Bernanke et al. (1999), and Neumann and von Hagen (2002), Germany was able to create a strong nominal anchor with its monetary targeting procedure. In the United States the strong nominal anchor has been Alan Greenspan (e.g., Mishkin, 2000). Although inflation targeting is one way to establish a strong nominal anchor, it is not the only way. It is not at all clear that inflation targeting would have improved performance in the United States during the Greenspan era, although it well might do so after Greenspan is gone if we are not as fortunate with the choice of the next Fed chairman (Mishkin, 2005). Furthermore, as has been emphasized in Calvo and Mishkin (2003) and Sims (2005), an inflation target by itself 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.

From the above perspective, 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:

5. Evidence that adoption of inflation targeting leads to an immediate fall in inflation expectations is not strong.[4]
6. Inflation persistence, however, is lower for countries that have adopted inflation targeting than for countries that have not.
7. Inflation expectations appear to be more anchored for inflation targeters than non-targeters: that is, inflation expectations react less to shocks to actual inflation for targeters than non-targeters, particularly at longer horizons.[5]

These results suggest that once inflation targeting has been in place for a while, it does make a difference because it better anchors inflation expectations and thus strengthens the nominal anchor. Inflation targeting could therefore lead to an even stronger nominal anchor in the United States even over what has been achieved under the "maestro" Alan Greenspan. Since recent theory on optimal monetary policy, sometimes referred to as the new neoclassical synthesis (Woodford, 2003, and Goodfriend and King, 1997), shows that establishing a strong nominal anchor is a crucial element in successful monetary policy, the evidence on anchoring inflation expectations provides a stronger case for the adoption of inflation targeting.

Our survey of the debate on whether inflation targeting matters indicates that there are still open questions, particularly on other dimensions of comparative macroeconomic performance in inflation targeting (IT) and non-inflation targeting (NIT) countries. Are inflation and output volatilities lower in IT countries? Do monetary policy and macroeconomic performance variables respond differently to shocks under IT? Are IT central banks more accurate in hitting their targets than NIT countries in maintaining or achieving a stable inflation?

This paper is devoted to focus on the latter questions. We address them in a systematic way, applying a common methodological approach, across issues and throughout the paper, based on four methodological choices. First, we look for empirical evidence in the world sample of 21 industrial and emerging-economy IT countries (termed ITers), before and after their adoption of IT, and compare their performance to a control group of 13 industrial countries without IT (termed NITers). Our choice of the latter control group is stringent because the macroeconomic and monetary policy performance of our NITers is among the best in the world, raising the odds against finding evidence of better performance among IT countries. Second, we distinguish between two types of IT regimes, one in which inflation targets are converging to, but are not yet at the long-run goal for inflation, and others in which the inflation target is stationary. This distinction is important because the strength of the nominal anchor, an important issue as we have seen above, may differ depending on whether inflation targets

[4] For example, Bernanke et al. (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) does find some evidence that expected inflation falls after announcement of inflation targets.

[5] Gurkaynak, Levin, and Swanson (2005), Levin, Natalucci, and Piger (2004), and Castelnuovo, Nicoletti-Altimari, and Palenzuela (2003).

are stable.[6] Third, we test for differences in group behavior of ITers and NITers – and for changes between pre-IT and post-IT changes among ITers – making statistical inferences from panel-data estimations, panel vector autoregressive models, and panel impulse responses. Finally, in order 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 sub-periods.

Section 2 of the paper describes more closely the two samples of ITers and NITers and presents comparative descriptive statistics on their inflation and growth performance. The following sections test for differences in performance between ITers and NITers – and for ITers between pre-IT and post-IT periods – in four dimensions. Section 3 revisits the question about country group differences in inflation behavior, extending previous research on the same issue to a country panel and considering alternative estimations methods and control groups. Section 4 tests for differences in country groups' dynamic response of inflation to oil-price and exchange-rate shocks, and of domestic interest rates to international interest-rate shocks. Section 5 measures differences in monetary policy efficiency, and output and inflation volatility. Section 6 reports differences between country groups in meeting inflation targets or objectives. Section 7 offers concluding remarks.

2. 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 IT country sample is comprised by eight industrial countries and 13 emerging economies that had full-fledged IT in place in late 2004.[7]

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

Here we follow much of the previous literature (e.g., Corbo, Landerretche, and Schmidt-Hebbel 2002, Mishkin and Schmidt-Hebbel 2002, Roger and Stone 2005) by dating IT adoption with the start of either partial of full-fledged IT, in opposition to other work that considers IT only at the start of full-fledged targeting (e.g., IMF 2005, Batini, and Laxton 2005). However, for the reasons mentioned above, we identify two distinct

[6] A second distinction between industrial and emerging-economy ITers is postponed for subsequent work.
[7] Therefore we exclude Finland and Spain, that adopted IT from 1993 and 1995, respectively, until adopting the euro in 1999.

post-adoption periods, according to the stationarity of the inflation target itself. During target convergence, inflation targets are adjusted downward, typically for calendar years and 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 occasional, slight adjustments in the target could be and actually are observed in some countries.[8] An important advantage of using the converging/stationary targets as identification for relevant post-IT periods is that this distinction is based an observable feature that is precisely dated, as opposed to the partial/full-fledged IT dichotomy, which is based on more subjective characteristics and dating.

Table 2.1 summarizes IT country information for the world population of ITers. The data sample used in this paper starts with the first quarter of 1989 and extends through the fourth quarter of 2004. Pre-IT sample periods range from 1 year (New Zealand, the most senior ITer) to 12 years (Iceland, Norway, Hungary, and the Philippines, the most recent ITers). Target convergence periods also differ significantly in extension, from no convergence (e.g., Australia and Thailand) to 11 years of convergence (Israel). The length of the stationary target period is also heterogeneous, extending from 1 year (Poland) to New Zealand (12 years).

Current, 2005, inflation target levels (or mid-points of target ranges) show little country variation. For the 8 stationary industrial countries, the average inflation target level stands at 2.2%. Among emerging economies, the average inflation target level is 3.0% for the sub-sample of 8 stationary ITers and 3.6% for the sub-sample of ITers that were still converging in 2004 toward future stationary target levels.

Figure 2.1 depicts inflation targets since IT adoption and 12-month CPI inflation rates for every ITer, based on quarterly data for 1989-2004. Visual inspection of the absolute differences between inflation and target levels suggests that IT countries have been successful in meeting their targets. However, more systematic testing of this hypothesis – and the corresponding comparison with a control group of NITers – is postponed to section 6 below.

Our control group of NITers is comprised by a selective set of 13 industrial countries that are at the international frontier of macroeconomic management and performance: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Portugal, and United States. In choosing this control group, we raise the stakes against finding evidence of better comparative performance under IT, considering that the world population of 21 ITers is comprised of a more heterogeneous country set regarding past performance, current macroeconomic institutions, and income levels.[9]

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[8] Countries that have adjusted discreetly their stationary target levels or ranges include the following: New Zealand and United Kingdom.

[9] Note that 10 of the 13 countries that for the control group have joined the Euro Zone 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 the lesser relevance of the results – that would arise if our control group were formed by developing countries.

Figure 2.2 shows that ITers and NITers had very different annual inflation rates in the late 1980s and early 1990s.[10] However, as time passed and IT was adopted during the 1990s, the inflation gap between ITers and NITers fell almost monotonically and was almost closed by 2004. This inflation convergence is largely due to the massive decline in inflation among emerging-economy ITers (Figure 2.3).

Comparative descriptive statistics on inflation performance confirm the latter facts (Table 2.2). ITers have been able to reduce average inflation rates from 12.6% before IT adoption to 4.4% since IT adoption. The inflation decline has been to 6.0% during post-adoption convergence, and further to 2.3% since attaining stationary targets. Emerging-economy ITers have recorded an average 4.4% inflation since their IT adoption, while the corresponding figure is only 2.2% in industrial-economy ITers. The latter figure is very close to the average 2.1% inflation recorded among NITers since 1997. A similar pattern is observed regarding inflation volatility (measured by the standard deviation of inflation). While inflation volatility in industrial ITers is twice the level recorded in NITers, inflation persistence is slightly lower in industrial ITers than in NITers. In section 3 below we test more systematically for significant differences in inflation performance between ITers and NITers, and controlling for possible IT regime endogeneity.

Comparative descriptive statistics on volatility and persistence of output growth and the output gap reflect the following (Table 2.3). Emerging ITers – as opposed to industrial ITers – have achieved a significant reduction in output growth and output gap volatility. NITers have also achieved a significant reduction in both volatility measures after 1997 – to levels that are below those recorded by industrial ITers. y performance. Output persistence, however, like inflation persistence, is lower in stationary-target ITers than in NITers since 1997.

3. Comparative Inflation Performance

Comparing inflation performance in inflation-targeting countries (ITers) and non-inflation targeting countries (NITers) has recently received increased attention (Ball and Sheridan 2005, Vega and Winkelried 2005, IMF 2005). The latter work is based only on cross-section evidence but differs significantly in the choice of control groups of NITers and estimation techniques. Not surprisingly, results also differ significantly, as summarized below. In this section we focus on the comparative performance in 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 lagged value, consistent with a standard partial-adjustment specification:

[10] Note that the country sample of ITers depicted in Figure 2.2 is held fixed over, including all years before IT adoption in each one of the 21countries.

$$(3.1) \quad \pi_{it} = \lambda \pi^*_{it} + (1-\lambda) \pi_{it-1} + \varepsilon_{it} ,$$

where π is observed 12-month CPI inflation, π^* is the unobserved long-term average 12-month CPI inflation, 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 is allowed to differ between ITers and NITers, according to the following specification based on an inflation-targeting regime dummy variable and controlling for country and time-specific effects:

$$(3.2) \quad \pi^*_{it} = \beta D_{it} + \alpha_i + \delta_t ,$$

where D is the IT regime dummy, β is its coefficient, α is a country fixed effect, and δ is a time fixed effect. For IT countries, D_{it} is set equal to 0 for periods before IT adoption and equal to 1 for periods of IT, while D_{it} is set equal to 0 for all periods corresponding to NITers.

Substituting equation (3.2) into equation (3.1) yields the following expression:

$$(3.3) \quad \pi_{it} = \lambda \beta D_{it} + (1-\lambda) \pi_{it-1} + \lambda \alpha_i + \lambda \delta_t + \varepsilon_{it}$$

Subtracting lagged inflation from both sides of equation (3.3) and taking t and t-1 as the periods before and after the IT adoption date, yields the following difference-in-difference cross-section specification used by Ball and Sheridan (2005) and IMF (2005) to test for inflation performance differences between ITers and NITers:

$$(3.4) \quad \pi_{i\,post} - \pi_{i\,pre} = \gamma_1 + \gamma_2 D_i - \gamma_3 \pi_{i\,pre} + \mu_{i,}$$

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

We summarize in Table 3.1 the cross-section results on comparative inflation performance reported by the previous literature. Ball and Sheridan (2005) reject any long-term differences between ITers and NITers regarding inflation mean, volatility, and persistence, for a sample of 7 industrial ITers and 13 industrial NITers. They attribute inflation performance improvement in industrial IT countries over time to reversion to the mean after the low-performance 1980s, as reflected by their reported significance of lagged inflation ($\pi_{i\,pre}$).[11]

IMF (2005), using a similar OLS cross-section estimation technique, come to the opposite conclusion. However, their treatment and control groups differ radically from those used by Ball and Sheridan – they compare inflation performance in 13 developing

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

ITers to a control group of 22 developing countries. They find that IT has helped developing ITers in reducing annual long-term inflation rates by 4.8% and by lowering long-term inflation volatility by 3.6%.

Finally, Vega and Winkelried (2005) use a matching (propensity score) technique applied to cross-country data for a treatment sample of 23 industrial and developing ITers, and a control group of 86 industrial and developing ITers. They report lower long-term annual inflation rates that range from 2.6% to 4.8% and lower long-term inflation volatilities by 1.5% to 2.0%. The similarity of the results by Vega and Winkelried to those reported by IMF suggests that sample differences weigh more heavily than differences in estimation techniques in the results reported by the three aforementioned studies.

Next we extend significantly the tests for differences in inflation performance reported by previous studies in 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 16 years and 34 countries. We check 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 IT treatment group (separating between industrial and developing ITers, and between stationary-target and converging-target ITers) and of our NIT control group (considering different combinations of the NIT sample and the pre-IT sample).

For comparison with the preceding studies, we start by estimating equation (3.4), applied to our full sample comprised by 21 developing and industrial ITers and 13 industrial NITers, using 1989-2004 quarterly data.[12] The results suggest that inflation has been 1% higher in IT countries than in NITers, on average, as reflected by the coefficient of the contemporaneous IT dummy variable (Table 3.2). Considering the estimated coefficient on pre-IT (pre-1997) inflation in ITers (NITers), equal to -0.85, the long-term average difference in inflation between ITers and NITers is estimated at 1.2%.[13] Also we note that our finding – the 1% higher inflation in IT countries – is estimated conditional on inclusion of the highly significant pre-IT (pre-1997) inflation rate. This estimate is much smaller than the unconditional inflation difference between ITers and NITers for the IT (post-1997) period, equal to 2.3 % (the difference between 4.37% and 2.07% reported in Table 2.2).

Our result stands in contrast with the negative inflation differences between ITers and NITers found by Vega and Winkelried (for developing and industrial countries) and 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 IT and NIT country group composition. We note that our sample composition is the most stringent (of all reported studies) against finding favorable effects of the IT regime

[12] For ITers, the pre-and post-IT adoption periods are identified in Table 2.2. For NITers, we follow the convention of the previous studies to use an arbitrary cut-off date that is consistent with the ITers' average IT adoption date. In our sample this date is at the end of 1996.

[13] However this result should be qualified because of the omission of country fixed effects and the possible endogeneity of the IT regime dummy, addressed below.

because our ITers comprise the world population of industrial and developing countries, while our control group is comprised only by high-achieving industrial NITers. Not surprisingly, we have found a significantly higher average inflation level in IT countries, conditional on their pre-IT (or pre-1997) inflation levels.

Now we proceed to extend the preceding cross-country studies by exploiting both the country and time dimension of our full panel sample, using both OLS and IV estimation techniques. We start by focusing on our full treatment sample comprised by all ITers but considering three several alternative control groups. Control group 1 is comprised by all 1989-2004 observations of our 13 NIT countries and the pre-IT observations of all subsequent ITers, implying a large panel dataset of 1942 quarterly observations for the full sample. Control group 2 is comprised by all 1989-2004 observations of our 13 NIT countries, without including the pre-IT observations of all subsequent ITers, implying a smaller panel of 1420 quarterly observations for the full sample. Lastly, control group 3 comprises all 1989-2004 observations of the pre-IT observations of all subsequent ITers, without including NIT countries, implying a panel of 1183 observations.

We turn back to equation (3.3), which is the relevant specification for our panel sample. Note that, in contrast to equation (3.4) and the corresponding results reported inTable 3.2, now we include inflation lagged by one quarter among the regressors, and not inflation of the pre-IT (pre-1997) period. For reference we start by reporting pooled OLS results with time dummies, one for each of the three control groups (columns 1, 2, and 3 in Table 3.3). We recall that all subsequent results on inflation differences between country groups are conditional to the inclusion of lagged inflation and hence are not directly comparable to the differences in unconditional inflation means that were reported in Table 2.2.

The results for control group 1 (first column in Table 3.3) show that the impact effect of the IT regime is to reduce inflation by 0.1% per year, with a long-term effect (considering the coefficient estimate of lagged inflation) of -1.9%. However, recall that we include high pre-IT inflation levels among subsequent ITers in control group 1. Dropping the latter sub-sample yields the results reported for control group 2 in column 3, which show no significant inflation difference between ITers and NITers. The estimation presented in column 5 reinforces the latter results: long-term inflation is a significant 5% lower among ITers, when compared with the pre-IT performance only.

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

Due to the lack of adequate instruments of the IT regime variable for our full panel sample, we estimate a parsimonious first-stage specification for the IT dummy as a function of its own lag and average pre-IT (pre-1997) inflation for ITers (NITers).[14] The results for various panel samples of ITers and NITers show that both variables are useful instruments of the IT regime dummy; hence we use them in our subsequent IV estimations.[15]

Returning to Table 3.3, we report IV results for the preceding specification of the inflation difference in columns 2, 4, and 6.[16] The qualitative results of columns 1, 3, and 5 are confirmed. When using control group 1 (that includes the ITers' pre-IT observations since 1989), inflation is shown to be lower among ITers. The corresponding estimations for control group 2 show that this result vanishes, finding no significant difference. Howeverusing control group 3, the lower inflation among ITers is magnified.

We find for control groups 1 and 3 (comparing results in columns 1 and 2, and in columns 5 and 6) that both the contemporaneous and long-term effects of the IT regime dummy on inflation differentials in IT countries is larger for the IV estimations. This suggests that the absolute size of the IT dummy coefficient is biased downward in the OLS estimations, by failing to take into account the endogeneity of IT to inflation. Using IV, the t estimated effect of IT is to lower long-run annual inflation by - 4.8% (compared to control group 1) and by 5% (compared to control group 3). However, there is no significant inflation difference between ITers and NITers (control group 2).

Are these results for our full treatment sample (comprised by all industrial and developing ITers) robust to considering different sub-samples of ITers? To address this question, we divide the full treatment sample first between industrial and emergingmarket ITers, and then between converging-target and stationary-target ITers. The corresponding results for our three control groups – using only IV panel estimation techniques – are reported in tables 3.4 and 3.5.

As above, we infer that estimated inflation differences between ITers and NITers depend largely on which control group is used. However, they also vary significantly with treatment groups, i.e., across different sub-samples of ITers.

The results for industrial ITers show that inflation is numerically lower but not significantly lower in industrial ITers than in control groups 1 and 3 (results in columns 1 and 5, Table 3.4). This result may be surprising, but we should recall that our econometric results are conditional to including the highly significant lagged inflation

[14] Some IT regime determinants (like central bank independence measures) included in the Mishkin and Schmidt-Hebbel cross-section probit estimation for IT are not available for time series, while other determinants (fiscal balance ratio to GDP, trade openness measures) were found to be not significant in our current panel data sample.
[15] Results of the first-stage regressions are available upon request.
[16] We use time dummies in all specifications with IV. For control groups 1 and 3, we also use country-specific dummies (fixed effects). In order to eliminate the bias that may arise because of the correlation between the fixed effects and the regressors due to the lags of the dependent variable, we use a within-estimation technique. Finally, we do not use fixed effects for control group 2, since the IT dummy would be perfectly correlated with the fixed effects. Therefore, for control group 2 we apply a standard pooled IV procedure to control for endogeneity.

variable. In contrast, we find evidence (significant at the 10% level) that inflation in industrial ITers is significantly lower than in NITers – by 0.06% on impact and by 1.1% in the long run. This result contradicts the comparable finding by Ball and Sheridan for industrial countries, based on OLS cross-section results.

The results for emerging-economy or developing ITers point toward a considerable gain in inflation. Compared to control groups 1 and 3, emerging ITers record a large and significant reduction of inflation (Table 3.4, columns 2 and 6), which is close to 0.8% on impact and 7% in the long term However, when compared to NITers only (control group 2 in column 4), emerging-economy ITers do not record inflation gains.

The results for converging-target and stationary-target ITers also confirm their key dependence on the choice of treatment and control groups. Regarding our control groups, the general result obtained above is confirmed: inflation differences tend to be in favor of ITers only in comparison to control groups 1 and 3. Inflation differences in favor of ITers are found to be highly significant in converging and not in stationary ITers.

We conclude from the evidence presented in this section the following. The evidence on comparative inflation performance of ITers and NITers reported by the previous literature and by us has shown that the effect on inflation can go either sign. Our findings suggest that the source of these differences lie in the use of heterogeneous control groups. The lack of use of panel data techniques in the previous literature has prevented 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 ITers and NITers is observed when the treatment group is compared to its own pre-IT experience. When NIT experiences are added to the control group, this effect declines but is still statistically significant. However, when the control group is restricted to NIT countries, no systematic significant difference in inflation is found between ITers and NITers.

Further disaggregation of the treatment group between industrial and emerging-economy ITers, and between converging-target and stationary-target ITers, yield mixed results. They confirm that results are highly dependent on the choice of control groups. They also suggest that emerging-economy and converging-target ITers record the largest gains in inflation reduction. Finally, industrial ITers exhibit a (statistically marginally significant) reduction in inflation in comparison to industrial NIT countries, a result that contradicts Ball and Sheridan.

4. Inflation and Policy Response to Shocks

If IT improves the credibility of monetary policy and a stronger anchoring of inflation expectations, we expect that under IT inflation would respond less to oil price shocks and there would be less of a pass-through effect from exchange rate shocks. As a result of more credibility and lower devaluation to inflation pass-through, IT may also contribute to stronger monetary policy independence (i.e., to a weaker reaction of domestic interest rates to shocks in foreign rates).

Therefore here we are interested in assessing whether ITers differ from NITers – and if post-IT differs from pre-IT among ITers – 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 whether a country has IT in place or not (in the spirit of the difference-in-differences approach). However, instead of using traditional country VAR models, we use a panel vector autoregressive model (Panel VAR) that permits using the larger data set on ITers and NITers employed in this paper.

Our approach to assess the impact of IT 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/or periods:

i) Inflation targeters (ITers) before the adoption of inflation targets,
ii) ITers after the adoption of IT,
iii) ITers after achieving stationary targets (ST IT),
iv) NITers before 1997, and
v) NITers after 1997.

The first group is formed by ITers during the period when they had not started IT yet. The sample period for this group is heterogeneous since it starts at the beginning of our sample (1989q1) but ends according to the date of adoption of IT in each country. The second group is formed by ITers during the period when they have IT. Contrary to the first group, the sample period is heterogeneous at the beginning but ends at the same period (2004q4). The third group is formed by ITers as long as they have achieved stationary targets. The results for this smaller sub-group might differ from the larger group of ITers because the transitional period from the adoption of IT to when targets become stationary may not be one of high credibility. Only when inflation targets become stationary might the full benefits of inflation targeting in achieving a strong nominal anchor be obtained. The fourth and fifth groups are comprised by the same countries without IT 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 estimate whether it is possible to find significant differences (statistically different from zero) between the responses before and after the adoption of IT in ITers (group 1 vs. group 2), before the adoption of IT and after ST IT (group 1 vs. group 3), before and after 1997 in NITers (group 4 vs. group 5), after IT in ITers and after 1997 in NITers (group 2 vs. group 5), and after ST IT and after 1997 in NITers (group 3 vs. group 5). We also split our treatment group sample (ITers) 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 to exploit our rich information set and gain efficiency in the estimation. Furthermore, this methodology allows for unobserved country heterogeneity and makes easier the exposition and analysis of aggregated results (see Holtz-Eakin et al., 1988; Love and Zicchino, 2002; and Miniane and Rogers, 2003, for applied studies using Panel VAR estimation). To our knowledge, this technique has not been used in preceding 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 (Helmert procedure) to remove the mean of all the future observations available for each country. This technique allows the use of lagged regressors as instruments and estimates the coefficients by system GMM. Finally, the responses to innovations in the system are identified using the Choleski decomposition of variance-covariance matrix of residuals and their confidence intervals are constructed by bootstrap methods. Since the assumption of independence among our samples could be not appropriate, we also use bootstrap methods to construct confidence intervals for differences in impulse-response functions instead of simply taking their differences.[17]

Our VAR system contains the following six variables (in this order): international oil price, international interest rate, inflation, output gap, 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, for reasons of parsimony a lag order of two was selected.

We start by discussing the impulse responses of inflation to oil price shocks (Figures 4.1, 4.2) and exchange rate shocks (Figures 4.3, 4.4), and end with the impulse responses of domestic to international interest rates (Figures 4.5, 4.6).[18] Each figure shows the dynamic response of one selected variable to a shock in another variable of the system. Each row of small figures focuses on a different comparison between the dynamic response of two sample groups. For instance, the first row of Figure 4.1 compares the response of ITers before their adoption of IT (first column) to the response of NITers after adopting IT (second column). Of special interest is the third column, which reports the difference between the preceding responses – the response in the

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

[18] We have 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 without interesting results.

second column minus the one in the first column – and their respective confidence interval.

The (positive) response of inflation to oil-price shocks is smaller in ITers after adopting IT and after achieving stationarity than before the adoption of IT (Figure 4.1). However, these differences are not statistically different from zero except for the first-quarter impact of oil price shocks on inflation, which is higher and slightly significant for the difference in ST IT. Surprisingly for NITers the opposite situation occurs. After 1997 the reaction of inflation to oil prices is larger than before 1997 and this difference is statistically different from zero after the second quarter of response. Comparing all ITers and stationary ITers with NITers after 1997, we observe that both ITers and ST ITers react slightly more than NITers to oil-price shocks in the first two quarters after the shock – this difference is statistically significant in the second case – but much less in the following quarters. However, in this last case these differences only seem significant at the sixth quarter after the shock.

To take into account now the sample heterogeneity in our full treatment group, we divide it into industrial and emerging-market ITers, and each of tye latter into the overall sample of ITers and stationary-target ITers. Our control group is comprised by NITers after 1997.[19] Figures 4.2.a and 4.2.b depict the response of inflation to a shock in oil prices, separately for industrial and emerging ITers. In both ITers (after IT) and ST ITers, inflation reacts less in emerging-market economies than in industrial economies. While the response of inflation is significant only until the second and first quarter after the shock in emerging ITers (after adopting IT) and emerging ST ITers, respectively, in industrial ITers and ST ITers the inflation reaction is positive and significant during the first six quarters after the oil-price shock. Also, when we compare the response against the control group, we observe that in all treatment groups inflation responds less to oil-price shocks than it does in NITers (after 1997) and this difference is significant at the sixth quarter. In the case of emerging ST ITers, this difference is stronger and earlier than in the other treatment groups: it is significant from the fourth to the sixth quarter (last row in Figure 4.2.b). The latter result shows that the preformance in emerging ST ITers is the main driving force behind the results found for the full sample of ITers (Figure 4.1).

From this comparative evidence on the inflation consequences of oil shocks, we conclude two points. First, IT generally helps ITers to get closer to the control group performance in responding to oil shock prices and also helps ITers to reduce the persistence of the inflation response to oil-price shocks in comparison to NITers. Second – and surprisingly, in contrast to industrial economies – stationary-target emerging-economy ITers exhibit a smaller inflation response to oil shocks than NITers.

Now let's turn to the inflation response to innovations in the exchange rate – a measure of devaluation-inflation passthrough. The positive response of inflation to exchange rate depreciation shocks is smaller in ITers after adopting IT in the first three

[19] Other comparisons, like those presented in the first three rows of Figure 4.1, do not yield results too different from those reported above. The same is true for the impulse responses to other variables, reported below.

quarters after the shock, but larger in the following periods (see Figure 4.3). However, we cannot reject that this difference is different from zero. Stationary ITers show a larger decline in the response of inflation to exchange rate shocks for the first three quarters and this difference is significant. We observe a smaller response of inflation to exchange-rate shocks in NITers after 1997 than in all ITers. This difference is statistically distinct from zero until the fourth quarter after the shock. This difference in favor of NITers still holds in the case of stationary ITers, but its magnitude and significance are smaller.

Next we separate our treatment group between industrial and emerging-economy ITers (Figure 4.4). industrial ITers (after IT) and industrial ST ITers exhibit a significantly smaller inflation response to exchange rate shocks than emerging ITers (after IT) and emerging ST ITers. While in both industrial-economies treatment groups (ITers and ST ITers) the pass-through is almost zero and non-significant in all periods, in both emerging-economy treatment groups pass-throughs are positive and significant at least until the fifth quarter after the shock. The differences in the response of both industrial treatment groups with respect to the control group are non-significant (see Figure 4.4.a). In contrast, the differences between the responses of both emerging treatment groups and the control group are larger and significant (see Figure 4.4.b).

In conclusion, IT helps in reducing the pass-through from exchange rate to inflation in the full sample comprised by all ITers but is not sufficient to achieve lower pass-through than in NITers, even in the case of stationary ITers. However, behind this aggregate result is the poorer performance of emerging-economy ITers, whose pass-throughs are significantly larger and more persistent than those observed in NITers. In contrast, industrial ITers and NITers do not exhibit any significant difference in pass-through performance.

Finally let's consider the issue of comparative monetary independence, reflected by the response of domestic interest rates to shocks in international interest rates. The positive response of domestic interest rate to international interest rate shocks is smaller in ITers after adopting IT and after achieving stationary IT than before adopting IT (Figure 4.5). In both cases these differences are statistically different from zero and they are higher in the second case. On the other hand, interest rates in NITers react more to international interest rates after 1997 – a possible result of including a large number of Euro Zone members in our control group. This difference is statistically significant only for the first three quarters after the shock. NITers (after 1997) react less than all ITers (including both the converging and the stationary period) and that difference is statistically different from zero. This suggests that IT during converging targets is not sufficient to achieve the level of monetary independence attained by NITers. However interest rates in stationary ITers respond to international interest rates in a similar way than in NITers, since the difference in their impulse response functions is not statistically different from zero. Hence monetary independence under stationary IT has converged to the levels observed among NITers.

Now let's focus on monetary independence separately in industrial and emerging ITers (Figure 4.6). The domestic interest rate reacts less to a foreign interest shock in industrial ITers (after IT) than what it does in emerging ITers (after IT) (see Figures 4.6.a and 4.6.b). However, the domestic interest rate reacts less in emerging ST ITers than in industrial ST ITers. Indeed, in emerging ST ITers this reaction is positive and significant only from the second to the fifth quarter. Therefore, we find that the full-treatment-group estimation hides two main results. First, there is no statistically significant difference in the response of domestic interest rates between industrial ITers (after IT) and the control group of NITers. This means that the worse performance of ITers as a group in comparison to NITers, depicted in Figure 4 (fourth row) is due to the worse performance of emerging ITers (first row in Figure 4.6.b). Second, that there is a slightly better performance (statistically significant at period 1) of emerging ST ITers, in comparion to the control group (second row in Figure 4.6.b). This means that the gains in monetary policy independence associated to IT are much larger in emerging ITers and accrue once they attain stationary targets, allowing them to achieving the performance of NITers.

Our main conclusions of this section point to major changes in monetary policy and performance associated to inflation targeting. First, IT helps in the full sample comprised by all ITers in reducing the response of inflation to oil-price shocks in comparison to their pre-IT period, and in comparison to the performance of NITers. Surprisingly, emerging ITers with stationary targets – in contrast to industrial ITers with stationary targets – exhibit a smaller and less persistent response of inflation to oil shocks than NITers. Second, IT helps in reducing somewhat the pass-through from exchange-rate devaluation to inflation in the full sample comprised by all ITers, but is not sufficient to achieve the low pass-through observed in NITers. While pass-throughs are the same in industrial ITers than in NITers, it is in emerging ITers where pass-throughs are significantly larger and more persistent than in NITers. Third, monetary policy independence has also been strengthened with the adoption of IT. The difference in the response of domestic interest rates to foreign interest rates between industrial ITers and NITers is not significant. In contrast, emerging ITers exhibit less monetary independence (a higher interest-to-interest rate response) during convergence to stationary inflation. Once they achieve stationary targets, however, their performance is not different from that of the control group of NITers.

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

One way of gauging macroeconomic performance is by focusing on the stability of inflation and real growth. The evidence reported in tables 2.2 and 2.3 shows that standard deviations of inflation and the output gap are larger in ITers than in NITers. One possible explanation is that NITers are hit by smaller shocks. Alternatively, NITers' central banks may be more efficient at implementing policies to meet their stabilization objectives. In this section we compute performance measures in order to identify the contribution of different monetary policy strategies to the observed differences in macroeconomic performance between NITers and ITers. Following Cecchetti and Krause (2001) and Cecchetti, Flores-Lagunes and Krause (2004), our approach involves estimating an inflation and output variability *efficiency frontier* that allows to derive measures of economic performance and monetary policy efficiency.

The performance of monetary policy can be assessed using the inflation and output variability tradeoff faced by the policy maker. This tradeoff allows us to construct an efficiency frontier that is 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. As is well known, aggregate supply shocks move output and inflation in opposite directions, forcing the monetary authority to face a tradeoff between inflation and output variability. Therefore the position of the efficiency frontier depends on the intensity of aggregate supply shocks: the smaller such shocks, the closer is the frontier to the origin (see Figure 5.1).

The efficiency frontier is also an indicator of the degree of optimality of monetary policy. When monetary policy is sub-optimal, the economy will exhibit large output and inflation volatility, and be at a significant distance from the frontier. Movements toward the efficiency frontier indicate improved monetary policy (Figure 5.1). These features of the efficiency frontier allow us to construct measures of economic and monetary policy performance in order to examine the contribution of policy efficiency and variability of shocks to the observed differences in macroeconomic performance between different samples of NITers and ITers.

Next, we follow closely the methodology derived by Cecchetti et al. (2004). However, in contrast to the latter authors, we do not apply it to individual countries but to IT and NIT country groups.

To obtain a measure of an economy's performance, in terms of output and inflation variability, we start with a standard conventional central bank objective, which is to minimize the following loss function determined by quadratic inflation and output deviations:

$$L = E\left[\lambda(\pi_t - \pi_t^*)^2 + (1-\lambda)(y_t - y_t^*)^2\right],$$

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 policy maker's weight attached to inflation.

The difference between observed performance measures of NITers (L_{NIT}) and ITers (L_{IT}) reflects differences in macroeconomic outcomes. If $\Delta L = L_{NIT} - L_{IT}$ is negative, NITers observe a better macro performance than ITers. A similar interpretation is given to the comparison of ITers before and after adopting IT. If $\Delta L = L_{IT-after} - L_{IT-before}$ is negative, ITers have recorded a performance gain after IT adoption.

However, this performance change can reflect either a change in the position of the efficiency frontier (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:

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

where $\overline{(\pi_t - \pi_t^*)}^2$ and $\overline{(y_t - y_t^*)}^2$ are the deviations of inflation and output from their targets under an optimal policy, respectively. 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 NITers and ITers, $\Delta S = S_{NIT} - S_{IT}$, reflects that the shocks that hit NITers are smaller. Alternatively, a negative value of $\Delta S = S_{IT-after} - S_{IT-before}$ implies that ITers face smaller shocks after IT adoption.

Finally, monetary policy efficiency is evaluated by measuring how close actual performance is to the one under optimal policy (i.e., the distance to the efficiency frontier):

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

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

Computation of the latter performance measures requires empirical estimates of the output-inflation variability frontier. This requires deriving 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 policy maker'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 tracing the entire efficiency frontier. Hence we proceed in two main steps. First, we estimate a simple dynamic aggregate demand and supply model. Then we use this estimate to construct the efficiency frontier.

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

$$y_{it} = \sum_{j=1}^{p} \phi_{1,j} i_{it-j} + \sum_{j=1}^{p} \phi_{1,(p+j)} y_{it-j} + \sum_{j=1}^{p} \phi_{1,(2p+j)} \pi_{it-j} + \sum_{i=j}^{p} \phi_{1,(3p+j)} px_{it-j} + \sum_{i=j}^{p} \phi_{1,(4p+j)} oil_{t-j} + v_{1i} + \varepsilon_{1it}$$
$$\pi_{it} = \sum_{j=1}^{p} \phi_{1,j} y_{it-j} + \sum_{j=1}^{p} \phi_{1,(p+j)} \pi_{it-j} + \sum_{i=j}^{p} \phi_{1,(2p+j)} px_{it-j} + \sum_{i=j}^{p} \phi_{1,(3p+j)} oil_{t-j} + v_{2i} + \varepsilon_{2it}$$

The first equation reflects an aggregate-demand function, where detrended output (y_{it}) for country i at time t is explained by *p* own lags, *p* lags of the nominal interest rate (i_{it}), and inflation deviations from targets or objectives (π_{it}). In addition we include *p* lags of two exogenous variables, the deviation of the oil price from trend (oil_t) and external price inflation[20], as well as a country fixed effect. The second equation represents a Phillips curve, where inflation deviations from its target or objective is a function of *p* own lags and *p* lags of detrended output. We estimate both equations for a group of countries (e.g., NITers, ITers) using the Generalized Method of Moments for dynamic panels (Arellano and Bond 1991).

Having obtained the estimation results for 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:

$$\min L = E\left[\lambda(\pi_t - \pi_t^*)^2 + (1-\lambda)(y_t - y_t^*)^2\right] = E\left(Y_t^{'} \Lambda Y_t\right),$$

subject to.

$$Y_t = BY_{t-1} + ci_{t-1} + DX_{t-1} + v_t ,$$

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

$$i_t = \Gamma Y_t + \Psi ,$$

where $\Gamma = -(c' Hc)^{-1} c' HB$ and $H = \Lambda + (B + c\Gamma)' H (B + c\Gamma)$. 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 calculate the optimal variances of inflation and output that are required to compute performance measures. We calculate

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

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.

Consistent with our measures in the other paper sections, our measures of inflation volatility are based on the deviation of CPI inflation from the inflation target for ITers and from a HP trend for NITers. For both county groups, output volatility is based on the output gap or deviation from an HP trend.

Now we are 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: (i) ITers before and after IT adoption, (ii) ITers before IT adoption and stationary ITers, (iii) NITers before and after the mean adoption date of IT (1997q1), (iv) ITers *vis-à-vis* NITers after 1997, and (v) stationary ITers against NITers since 1997q1. As above, we also present here separate results for emerging and industrial economies.

Table 5.1 reports the estimated comparative measures of economic performance P, monetary policy efficiency E, and variability of supply shocks S for each pair of country groups. Figures 5.2 – 5.6 depicts actual performance points P and efficiency frontiers consistent with E, for each pair of country groups. We follow Cecchetti, Flores-Lagunes, and Krause (2004) in using a value of λ – the weight attached to inflation deviations in the loss function – equal to 0.80. The latter value is also consistent with the empirical estimates for IT and non-IT countries reported by Cecchetti and Ehrmann (2002) and Corbo, Landerretche, and Schmidt-Hebbel (2002).

The first two rows of Table 5.1 report the estimated measures for ITers before and after IT adoption. Macroeconomic performance between these periods has improved, as volatility of inflation and output have shrunk (see also Figure 5.2), reflected by the negative value of ΔL, at -3.817. The gain in performance can be decomposed into a gain in efficiency ΔE (by -0.882, equivalent to a 23.1% contribution), reflected by getting closer to the efficiency frontier, and a smaller variability of shocks hitting the economy, ΔS (by -2.935, equivalent to a 76.9% contribution), reflected by a shift of the efficiency frontier. Another way to confirm the contribution of shocks and policy efficiency to the initial and final positions P1 and P2 is reflected by the quantitative decomposition of the latter position, summarized in the second row of Table 5.1. Efficiency (E1) explains 35.3 % of pre-IT performance P1, a share that rises to 45.7% after IT adoption.

The second comparison (rows 3 and 4 in Table 5.1 and Fig. 5.3) reflects a much larger improvement or macro performance reaped once ITers have achieved stationary inflation targets. The position of the efficiency frontier of stationary targeters has shifted much closer to the origin and so has the actual performance. Moreover, the relative contribution of efficiency improvement to the latter shift is larger (34.2%) under stationary IT than under IT in general (23.1%).

The third comparison reflects an improvement in macroeconomic performance among NITers after the mean adoption date of the IT regime, which is the first quarter of 1997. In contrast to the previous cases, the observed improvement in performance is more than fully explained by smaller shocks (146.9%) that have mitigated the deterioration of monetary policy efficiency. The contribution of inefficiency of monetary policy to the initial and final positions has increased from 14.9% to 47%.

The fourth and fifth comparisons are between ITers and NITers after 1997. ITers in general (including both converging and stationary ITers) exhibit actual performance levels, efficiency frontier positions, and policy efficiency levels that are worse than those of NITers (Fig. 5.5). However, stationary ITers get much closer to the performance and efficiency levels of NITers (Fig. 5.6). The difference in performance between NITers and ITers (-1.436) is largely due to larger shocks (64.4%) and to a lesser degree to lower policy efficiency (35.6%).

When we consider emerging and industrial ITers as separate sub-samples, we find that emerging ITers not only exhibit larger fluctuations in output and inflation but they are also further away from their efficiency frontier (Figs 5.5b and 5.5c). As reflected by rows 6 and 7 of Table 5.1, the distance of emerging ITers from their efficiency frontiers more than doubles the distance exhibited by industrial ITers (3.1 vs 1).Therefore, industrial ITers are much closer in performance to NITers. However, the relative difference in performance due to shocks and efficiency is almost similar for emerging and industrial ITers. In both cases, around 45% of difference in performance is explained by lower policy efficiency while the remaining 55% is explained by larger shocks. The difference due to inefficiency of monetary policy between ITers and NITers becomes smaller when we exclusively consider industrial stationary ITers. In this case, only 32.5% of the difference in performance is explained by policy inefficiency while 67.5% is explained by larger shocks.

Our conclusion from the evidence in this section is that countries adopting IT have had a substantial improvement in the efficiency of monetary policy. Furthermore, the gains in efficiency are larger for stationary ITers than for ITers in general. The likely source of this improvement is when ITers finally achieve sufficient disinflation to stabilize their inflation targets, they have gained credibility which helps monetary policy outcomes to be closer to the efficiency frontier. Although IT improves monetary performance, it still remains true that our control group of NITers has higher efficiency in the conduct of monetary policy. This may be due to the more difficult monetary policy environment faced by many countries who felt that they needed to adopt IT.

6. Inflation Accuracy

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

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

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

We report absolute inflation deviations for several country groups and for 1989-2004 and sub-periods, according to our two measures, in Table 6.1 and Figure 6.1. For ID1 (based on the deviation from actual targets for IT countries while they have IT in place), the median absolute inflation deviation is 1.03% for ITers and 0.54% for NITers. However, for ID2 (based on the deviation from HP inflation trends for IT countries while they have IT in place), the median absolute inflation deviation is lower and equal to 0.84%, still higher than the unchanged median of 0.54% for NITers. The inflation deviation based on actual inflation targets (ID1) for ITers is systematically larger than the one based on HP filtered inflation trends (ID2) across all sub-groups of IT countries. This suggests our conjecture that the use of HP filtered inflation trends as a proxy for implicit inflation objectives for NITers and for ITers during the pre-IT period may bias downward the measures for inflation deviations in ITers and hence bias upward the reported differences of deviations between ITers and NITers.

The time pattern of median absolute inflation deviations for ITers and NITers, according to both measures, is depicted in Fig. 6.1. NITers exhibit systematically lower inflation deviations than ITers. However, ITers' median inflation deviations show a negative trend during 1989-2004, as opposed to the stationary character of median inflation deviations of NITers.[21]

Within ITers, large differences in hitting targets are observed between different country groups. According to the ID1 measure, the median absolute inflation deviation is 0.77% in industrial economies, a figure that rises to 1.28% in emerging economies. The difference is even larger when splitting IT experiences according to the period of converging targets, when median absolute inflation deviations are 1.49%, and stationary target periods, when deviations attain 0.77%. As expected, the largest difference is observed among two very heterogeneous NIT experiences: before IT adoption, median absolute inflation deviations were 1.12% among ITers while the comparable figure is 0.36% among NITers.

It is misleading to claim that the prima facie evidence of poorer inflation accuracy in IT countries is conclusive. Many large inflation objective misses could be explained by idiosyncratic country or time period shocks – and these could be correlated with adoption of IT, particularly in emerging economies. Therefore we will test for significant differences in inflation deviations between ITers and NITers, controlling for potential determinants of inflation shocks.

Following previous work on differences in inflation deviations among ITers (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 ($|\pi_{it} - \pi^*_{it}|$):

(6.1) $$|\pi_{it} - \pi^*_{it}| = \sum_{j=1}^{r} \phi_j |\pi_{it} - \pi^*_{it}| + \alpha IT_{it} + X_{it}\beta + c_i + e_{it},$$

as a function of its own lag, a number of relevant inflation-shock controls (X_{it}), a dummy variable (IT_{it}) that takes a value of 1 if the country has an IT regime in place or 0 otherwise, and country and time-specific effects. The inflation deviation is defined as the absolute value of the difference between the 12-month CPI inflation rate (π_{it}) and the annual inflation target (π^*_{it}). The vector of control variables is comprised by 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 Fed Funds rate absolute deviation from trend and the absolute international oil price deviation from trend).

We estimate our model for absolute inflation deviations in equation (6.1) using an unbalanced panel sample of 21 IT and 12 NIT countries and quarterly observations for 1989-2004. As in preceding sections, we consider here two alternative control groups: control group 1, comprised by the full NIT sample of industrial NIT countries that never had IT in place and the pre-IT observations of all subsequent ITers, and control group 2,

[21] We reject the presence of non-stationarity in all four series at 1% of confidence using the Augmented Dickey-Fuller and Phillips-Perron unit root tests.

comprised only by the industrial NIT countries that never adopted the regime. Furtheremore, we control for possible endogeneity of the choice of the IT regime (the IT dummy variable) and the two domestic shocks, using as instruments the variables listed at the bottom of Tables 6.2 and 6.3, and making use of panel-data IV estimation. For control group 1 we obtain the fixed-effects estimator but for control group 2 we are unable to estimate a fixed-effects model due to the presence of time-invariant variables. To tackle this problem, we follow Plümper and Troeger (2004) that obtain a modified Hausman-Taylor IV estimator to compute the coefficients of time-invariant variables.[22]

The results are reported in Table 6.2 (using the ID1 measure as dependent variable) and Table 6.3 (using the ID2 measure as dependent variable). Each table presents results for the two alternative NIT control groups, and of alternative IT dummies (one for all IT country experiences and dummies that capture a heterogeneous effect of IT for converging and stationary IT periods and for emerging and industrial IT countries).

Inflation deviations exhibit systematic persistence as reflected by the significant coefficient of the lagged dependent variable. Its point estimate – close to 0.5 across the 10 results reported in Tables 6.2 and 6.3) shows that 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 – the IT dummy – exhibits a robust negative coefficient across all regressions but is only significant when we use the first control group. For example, column (1) in table 6.2 reports that the contemporaneous effect of IT is to reduce absolute inflation deviations by 0.18%, when using the ID1 measure and the full sample of NIT country experiences (control group 1). Moreover, the contemporaneous impact of IT on absolute inflation deviations rises in magnitude from -0.18 to a long-term effect of -0.40 (= 0.18% / (1-0.54)). The effect of IT increases to -0.45% but is non-significant when excluding pre-IT experiences in IT countries (columns 2). The latter result is the relevant one when comparing IT experiences to those of countries that never had IT in place.

The result in column 1, based on ID1, is larger when using the ID2 measure, reported in column 1 of Table 6.3, which yields -0.27%, confirming the fact, noted above, that inflation target deviations from actual targets lead to higher deviations than those measured as deviations from HP filtered trends. This suggests that comparing actual deviations from observable targets in IT countries with HP filter-inferred deviations from non-observable inflation objectives in NIT countries leads to an upward bias in ITers' deviations compared to those of NITers. Therefore the reported coefficients for the IT

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[22] This procedure can be summarized in three steps. First we estimate a panel fixed-effects model excluding time-invariant right-hand side variables. Then 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, and 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.

regime based on the ID1 measures are likely to be lower-bound estimates, while those based on the ID2 measure might be closer to the non-observable regime difference.

Columns 3-5 in Tables 6.2 and 6.3 report coefficients for separate IT dummy variables for converging-target and stationary-target IT periods, and for emerging and industrial ITers. For both cases, the coefficients exhibit the expected negative sign but vary in significance and magnitude. The results in column 3 shows that converging ITers exhibit about 0.26% lower absolute deviations of inflation, while the results for stationary ITers vary from –0.13% to -0.26%. When we restrict the control group to the NIT countries that never had IT in place, the results remain negative but loose statistical significance. Column 5 presents the coefficients that capture separate effects of IT on emerging and industrial economies. Only emerging countries show a significantly lower inflation deviation than that observed in control group 1. However, when using the ID2 measure, the results suggest that both emerging and industrial ITers observe lower absolute inflation deviations (of similar magnitude) than those observed in control group 1.

To check for robustness of our results to the underlying assumptions on the Hodrick-Prescott filtering procedure to obtain inflation trends as proxies for inflation objectives, we run the regressions reported in columns 2 and 6 of Table 6.2 on alternative absolute inflation deviation series based on different values of the Hodrick-Prescott filter smoothing parameter used in obtaining trend inflation series. (The coefficient used in all HP filtered trends used in this paper is the standard lambda equal 1600 for quarterly data). Figure 6.2 depicts the estimated coefficient of the IT dummy variable for alternative smoothing parameter values that range from 100 to 10,000. The figure suggests that the IT coefficient estimates of -0.18 and -0.27 in column 1 of Tables 6.2 and 6.3 are robust to wide ranges of alternative HP smoothing parameters.

We conclude the following from the results reported in this section. Prima facie, inflation deviations from inflation targets or objectives are larger in IT than in NIT 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 IT regime experiences (across countries and over time). Controlling for the latter shocks, the econometric findings reported here point toward a much more differentiated performance regarding inflation accuracy under IT. First, when comparing all ITers (and also largely the emerging-industrial and coverging/stationary sub-samples) to all NIT experiences (including NIT countries and pre-IT experiences, comprised by control group 2), inflation deviations are smaller in IT than in NIT countries. The point estimates for the IT impact gain in inflation deviations ranges from 0.18% to 0.45% (and roughly twice the latter range for the long-term IT gain) for the full experience of IT countries and periods. However, this result is not robust to using the alternatuive control group comprised only by NIT countries. While inflation deviations are still smaller in IT countries, the corresponding coefficients are not anymore significantly different from zero. When using our preferred inflation deviation measure ID2 and disaggregating all ITers between different sub-groups, we obtaon that the IT lowers absolute inflation deviations by similar amounts in emerging and industrial, and in converging and stationary ITers.

7. Concluding Remarks

This paper has provided panel evidence on whether monetary performance is improved by inflation targeting for countries that have adopted inflation targeting, in comparison to both their pre-IT experience and to a control group of successful industrial non-inflation targeting countries. In general our evidence is supportive of inflation targeting. IT seems to help countries achieve lower inflation in the long run, have smaller response to oil price and exchange rate shocks, strengthen monetary policy independence, improve monetary policy efficiency, and obtain inflation outcomes closer to target levels. Furthermore, some benefits of inflation targeting are larger when inflation targeters have achieved disinflation and are able to make their inflation targets stationary. This may suggest that the credibility of an inflation targeting regime improves once it has had success with disinflation and becomes a stationary regime.

Hence inflation targeting seems to be the natural monetary-regime choice for emerging-market economies who aim at improving their monetary policy efficiency under adequate fiscal and institutional conditions. Not surprisingly, a large number of developing countries are currently planning adoption of inflation targeting in the near future.[23]

Despite these favorable results for the results attained by inflation-targeting countries over time, our evidence generally does not suggest that countries that adopt inflation targeting have attained better monetary policy performance relative to our control group of NITers, 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 control group, particularly during the mature phase of stationary targeting.

The one exception to the generally better performance of our control group is the attainment of inflation targets or objectives. Controlling for exogenous inflation shocks, we have found preliminary evidence that ITers are more successful than NITers in reducing inflation deviations. While this result is tentative because of the non-observed nature of inflation objectives in the control group of NITers, our sensitivity analysis suggests that this results may be robust. It also seems consistent with the very nature of inflation targeting, which helps focus central banks more narrowly on minimizing inflation deviations (for a given output gap) and contributing to stronger credibility by anchoring inflation expectations to explicit inflation targets.

[23] In this version of the paper we have not been able to conduct our tests separating inflation targeters into industrial and emerging-market economies. Our suspicion is that the gains from inflation targeting are highest for the latter group. We plan to do these additional tests subsequently and will incorporate the results into the revised paper version.

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

Nevertheless, we see advantages for adoption of inflation targeting even in industrial countries. There are four problems that face industrialized countries that have not adopted inflation targeting (see Bernanke et al. 1999, and Mishkin 2005). First, the strong nominal anchor that has produced successful monetary policy is often based on individuals, and their replacements may not have as strong a commitment to the nominal anchor. Second, there is the possibility that the focus on the long-run exhibited by successful NITers, 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 has the potential to 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 NITers in recent years continues in the future.

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Table 2.1
Inflation-Targeting Periods and 2005 Target Levels in 21 IT Countries

Countries	Pre-IT Period		IT Period				2005 Inflation Target Level (%)
			Converging Target Period		Stationary Target Period		
Industrial Economies							
Australia	1989q1	1994q2			1994q3	2004q4	2-3
Canada	1989q1	1990q4	1991q1	1994q4	1995q1	2004q4	1-3
Iceland	1989q1	2000q4	2001q1	2002q4	2003q1	2004q4	2.5
New Zealand	1989q1	1989q4	1990q1	1992q4	1993q1	2004q4	1-3
Norway	1989q1	2000q4			2001q1	2004q4	2.5
Sweden	1989q1	1994q4			1995q1	2004q4	2 (+/-1)
Switzerland	1989q1	1999q4			2000q1	2004q4	<2
United Kingdom	1989q1	1991q4			1992q1	2004q4	2
Average 8 countries							*2.2*
Emerging Economies							
Brazil	1989q1	1998q4	1999q1	2004q4			4.5 (+/-2.5)
Chile	1989q1	1990q4	1991q1	2000q4	2001q1	2004q4	2-4
Colombia	1989q1	1998q4	1999q1	2004q4			5 (+/-0.5)
Czech Republic	1989q1	1997q4	1998q1	2004q4			3 (+/-1)
Hungary	1989q1	2000q4	2001q1	2004q4			3.5 (+/-1)
Israel	1989q1	1991q4	1992q1	2002q4	2003q1	2004q4	1-3
Korea	1989q1	1997q4	1998q1	1998q4	1999q1	2004q4	2.5-3.5
Mexico	1989q1	1998q4	1999q1	2002q4	2003q1	2004q4	3 (+/-1)
Peru	1989q1	1993q4	1994q1	2001q4	2002q1	2004q4	2.5 (+/-1)
Philippines	1989q1	2000q4	2001q1	2004q4			5-6
Poland	1989q1	1997q4	1998q1	2003q4	2004q1	2004q4	2.5 (+/-1)
South Africa	1989q1	1999q4			2001q1	2004q4	3-6
Thailand	1989q1	1999q4			2000q1	2004q4	0-3.5
Average 8 stationary target countries							*3.0*
Average 5 converging target countries							*3.6*

Figure 2.1 Annual Inflation Rates and Targets in IT Countries, 1990-2004

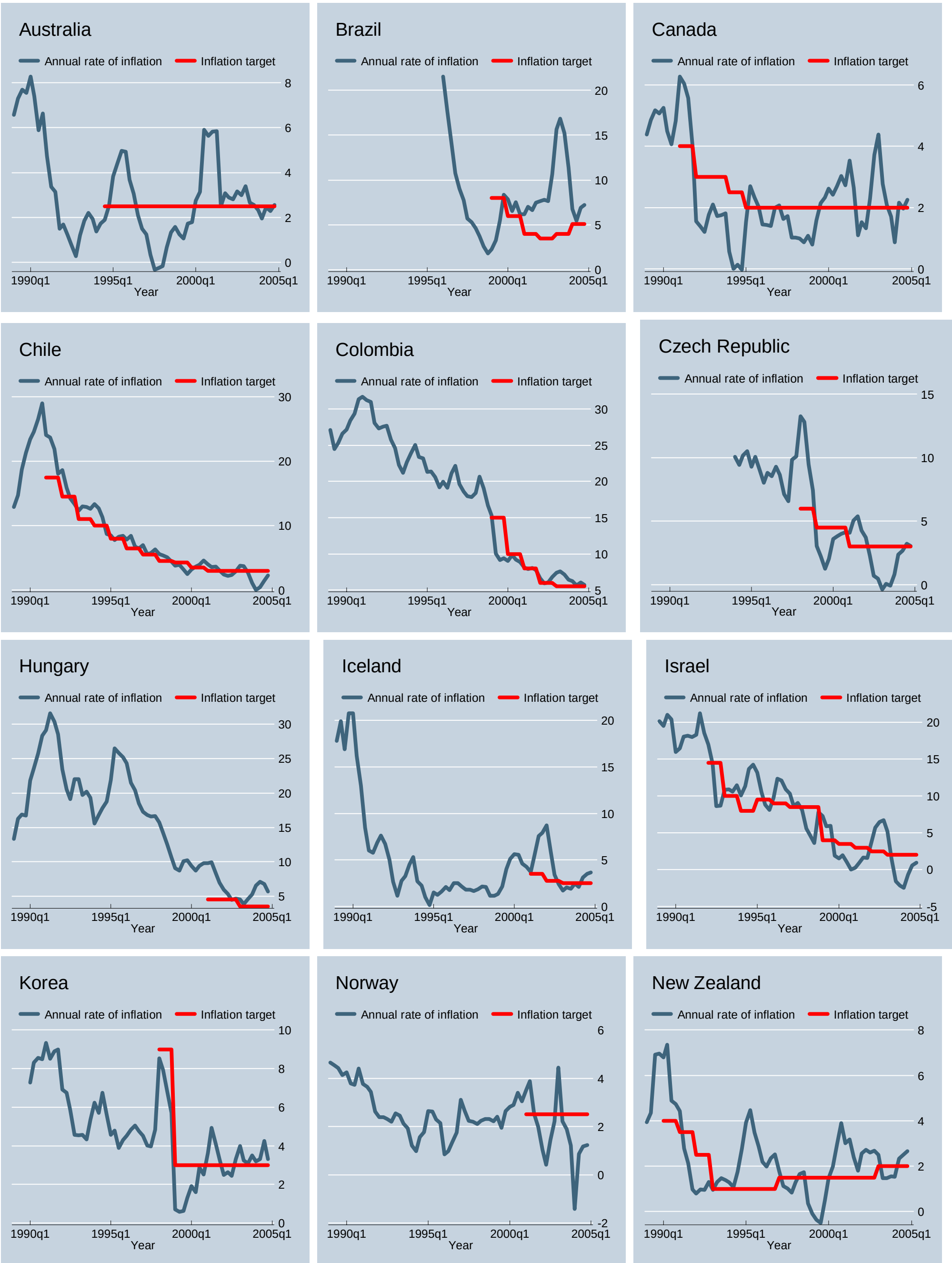


Figure 2.1 Annual Inflation Rates and Targets in IT Countries, 1990-2004 (cont.)

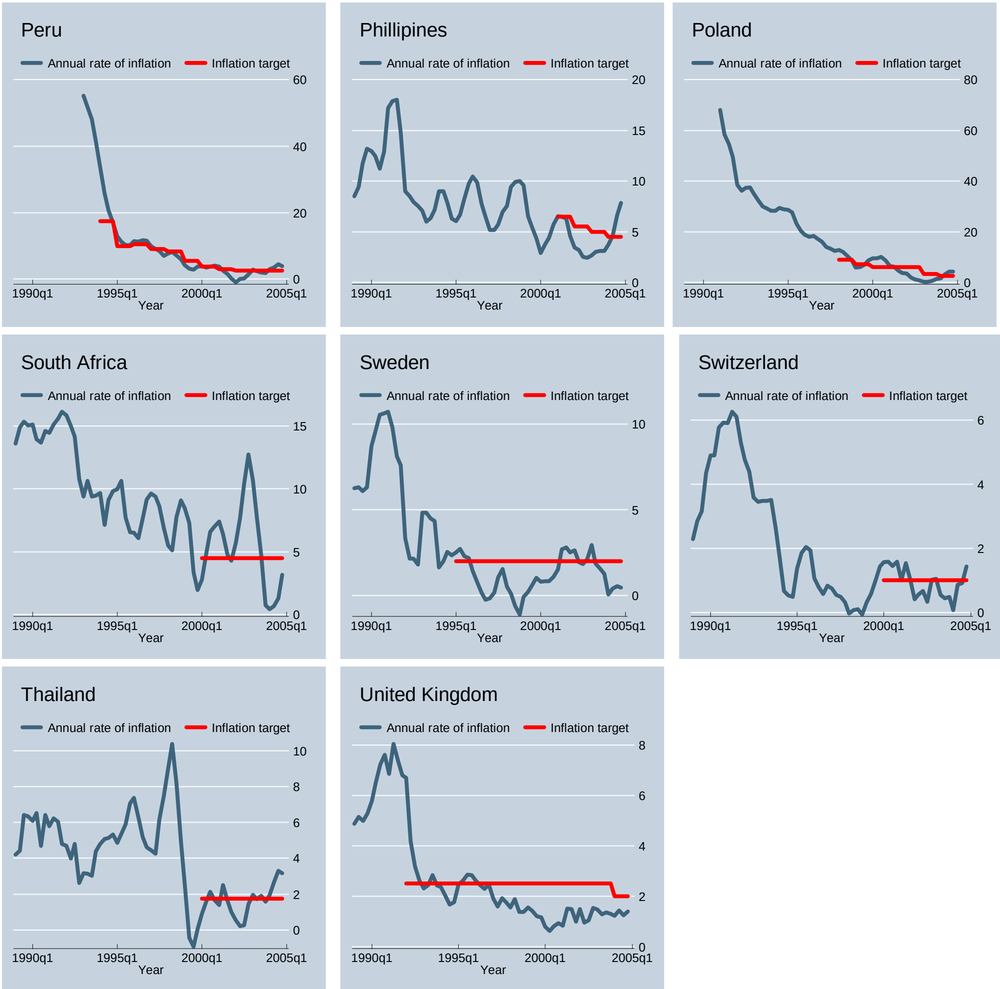
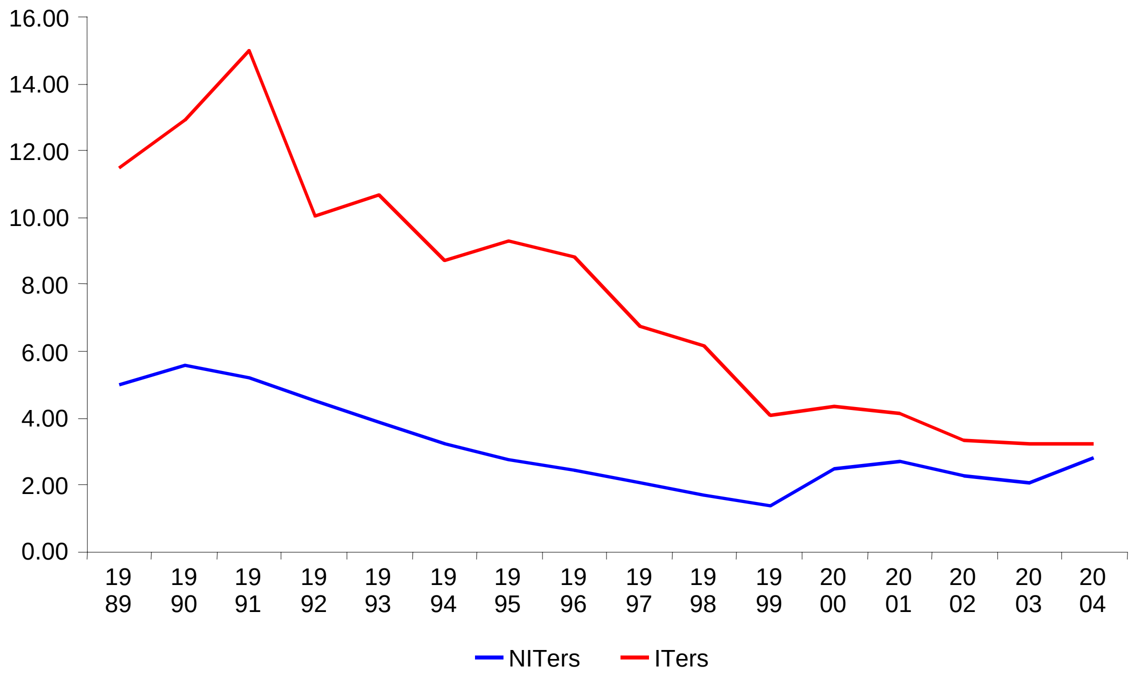
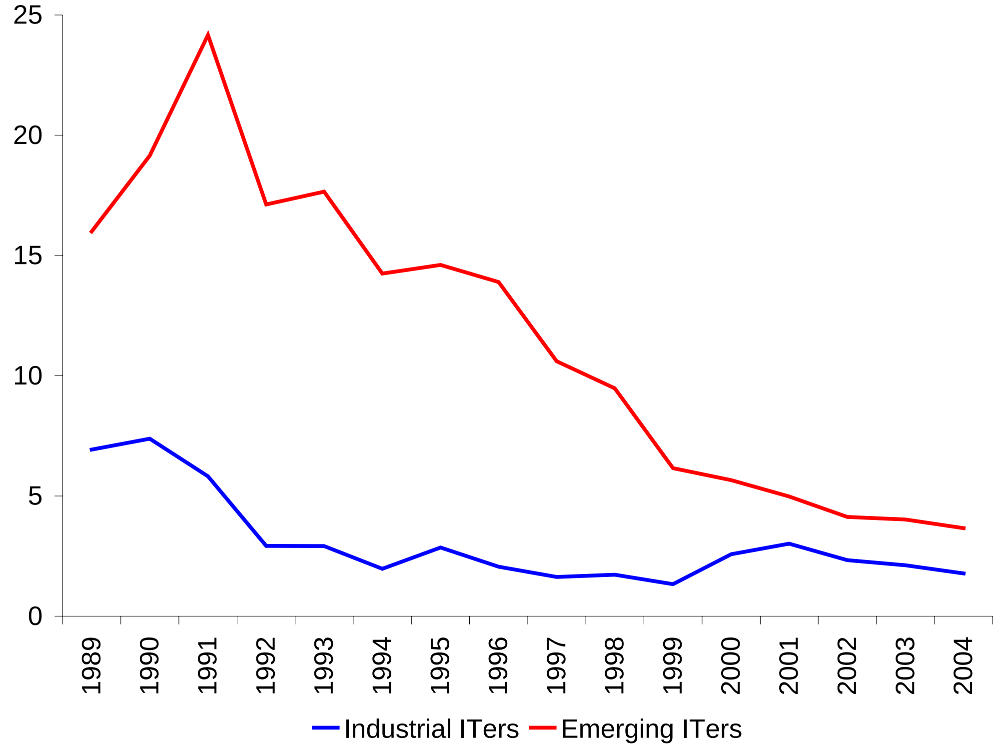


Figure 2.2
Average Annual CPI Inflation Rates in IT and NIT countries, 1989-2004



Note: annual averages of inflation for 21 IT countries and 13 NIT countries, identified in section 2. Inflation are averages of 4 quarterly 12-month CPI inflation rates for the corresponding year.
Source: authors' calculations based on IFS (IMF) data.

Figure 2.3
Average Annual CPI Inflation Rates in Industrial and Emerging IT countries, 1989-2004



Note: annual averages of inflation rates for 9 industrial IT countries and 12 emerging IT countries, identified in section 2. Inflation rates are averages of 4 quarterly 12-month CPI inflation rates for the corresponding year.
Source: authors' calculations based on IFS (IMF) data.

Table 2.2
Descriptive Statistics on Inflation Levels, Volatility, and Persistence of ITers and NITers, 1989-2004

ITers		NITers	
Pre IT adoption		**1989-1996**	
Full sample			
Mean	12.63	Mean	4.01
Standard deviation	3.91	Standard deviation	1.37
Persistence	0.83	Persistence	0.91
Industrial-economy ITers			
Mean	4.73		
Standard deviation	2.16		
Persistence	0.79		
Emerging-economy ITers			
Mean	18.56		
Standard deviation	5.23		
Persistence	0.87		
Post IT adoption		**1997-2004**	
Full sample			
Mean	4.37	Mean	2.07
Standard deviation	2.63	Standard deviation	0.79
Persistence	0.81	Persistence	0.83
Industrial-economy ITers			
Mean	2.24		
Standard deviation	1.40		
Persistence	0.76		
Emerging-economy ITers			
Mean	5.97		
Standard deviation	3.55		
Persistence	0.85		
Converging-target ITers			
Mean	6.04		
Standard deviation	3.11		
Persistence	0.78		
Stationary-target ITers			
Mean	2.32		
Standard deviation	1.29		
Persistence	0.71		

Note: persistence is measured as the estimated coefficient of an AR(1) equation for inflation.
Source: authors' calculations based on IFS (IMF) data.

Table 2.3
Descriptive Statistics on GDP Growth and Output Gap Volatility and Persistence of ITers and NITers, 1989-2004

ITers		NITers	
Pre IT adoption		**1989-1996**	
Full sample			
Std dev GDP growth	3.04	Std dev GDP growth	4.01
Std dev output gap	1.87	Std dev output gap	1.37
Persistence GDP growth	0.75	Persistence GDP growth	0.73
Persistence output gap	0.65	Persistence output gap	0.71
Industrial-economy ITers			
Std dev GDP growth	2.01		
Std dev output gap	1.36		
Persistence GDP growth	0.75		
Persistence output gap	0.69		
Emerging-economy ITers			
Std dev GDP growth	3.81		
Std dev output gap	2.26		
Persistence GDP growth	0.75		
Persistence output gap	0.63		
Post IT adoption		**1997-2004**	
Full sample			
Std dev GDP growth	2.23	Std dev GDP growth	2.07
Std dev output gap	1.36	Std dev output gap	0.79
Persistence GDP growth	0.74	Persistence GDP growth	0.74
Persistence output gap	0.75	Persistence output gap	0.68
Industrial-economy ITers			
Std dev GDP growth	2.15		
Std dev output gap	1.29		
Persistence GDP growth	0.74		
Persistence output gap	0.72		
Emerging- economy ITers			
Std dev GDP growth	2.30		
Std dev output gap	1.41		
Persistence GDP growth	0.76		
Persistence output gap	0.78		
Converging-target ITers			
Std dev GDP growth	2.43		
Std dev output gap	1.50		
Persistence GDP growth	0.68		
Persistence output gap	0.76		
Stationary-Target ITers			
Std dev GDP growth	1.52		
Std dev output gap	1.15		
Persistence GDP growth	0.55		
Persistence output gap	0.61		

Note: persistence is measured as the estimated coefficient of an AR(1) equation for inflation.
Source: authors' calculations based on IFS (IMF) data.

Table 3.1
Inflation Difference between ITers and NITers in Previous Literature

	Sample	Estimation technique	Long-term inflation level difference	Long-term inflation volatility difference	Long-term inflation persistence difference
Ball and Sheridan (2005)	ITers: 7 industrial economies NITers: 13 industrial economies	Cross-section, OLS	Zero	Zero	Zero
Vega and Winkelried (2005)	ITers: 23 ind. and emer. Economies NITers: 86 ind.and em. Economies	Cross-section, Propensity score matching	2.6% to 4.8%	1.5% to 2.0%	Ambiguous
WEO (2005)	ITers: 13 emerging economies NITers: 22 emerging economies	Cross-section, OLS	4.8%	3.6%	n.a.

Table 3.2
Inflation Difference between IT and NIT countries (cross-section OLS estimation)

Inflation targeting dummy	1.007 (0.093)*
Pre-IT (pre-1997) Inflation	-0.850 (0.000)***
Constant	1.468 (0.002)**
R2	0.973
Observations	34
Number of Countries	34

Note: p values in parentheses.
* Significant at 10%, ** significant at 5%, *** significant at 1%.

Table 3.3
Inflation Difference between ITers and NITers (panel sample)

	Control group 1		Control group 2		Control group 3	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Pooled OLS	**Panel IV**	**Pooled OLS**	**Pooled IV**	**Pooled OLS**	**Panel IV**
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)
Observations	1942	1942	1420	1420	1183	1183
Number of Countries	34	34	34	34	21	21

Note: p-values in parenthesis.
Control group 1 includes all NITers and pre-ITers; control group 2 includes all NITers; control group 3 includes pre-ITers. Control group 2 regressions cannot be estimated with panel data since country fixed effects are perfectly collinear with IT. Instruments used in control group 1 and 3: lagged IT dummy and initial inflation; instrument used in control group 2: initial inflation. Time dummies included for every quarter.
* Significant at 10%, ** significant at 5%, *** significant at 1%.

Table 3.4
Inflation Difference between ITers and NITers, separating between industrial and emerging-economy ITers

	Control group 1 (Panel IV)		Control group 2 (Pooled IV)		Control group 3 (Panel IV)	
	(1) Industrial Economies	(2) Emerging Economies	(3) Industrial Economies	(4) Emerging Economies	(5) Industrial Economies	(6) Emerging Economies
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)***
Observations	1590	1613	1080	1099	831	854
Number of Countries	34	33	22	25	21	20

Note: p-values in parenthesis.
Control group 1 includes all NITers and pre-ITers; control group 2 includes all NITers; control group 3 includes pre-ITers. Control group 2 regressions cannot be estimated using panel-data techniques since country fixed effects are perfectly collinear with IT. Instruments used in control group 1 and 3: lagged IT dummy and initial inflation; instrument used in control group 2: initial inflation. Time dummies included for every quarter.
* Significant at 10%, ** significant at 5%, *** significant at 1%.

Table 3.5
Inflation Difference between IT Groups and Inflation Difference between ITers and NITers, separating between stationary and converging-target ITers

	Control group 1 (Panel IV)		Control group 2 (Pooled IV)		Control group 3 (Panel IV)	
	(1) Stationary ITers	(2) Converging ITers	(3) Stationary ITers	(4) Converging ITers	(5) Stationary ITers	(6) Converging ITers
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)
Observations	1636	1567	1118	1050	877	808
Number of Countries	34	34	24	27	21	21

Note: p-values in parenthesis.
Control group 1 includes all NITers and pre-ITers; control group 2 includes all NITers; control group 3 includes pre-ITers. Control group 2 regressions cannot be estimated using panel-data techniques since country fixed effects are perfectly collinear with IT. Instruments used in control group 1 and 3: lagged IT dummy and initial inflation, instrument used in control group 2: initial inflation. Time dummies included for every quarter.
* Significant at 10%, ** significant at 5%, *** significant at 1%.

Figure 4.1
Response of Inflation to a Shock in Oil Prices, Full Treatment Group (ITers) Sample

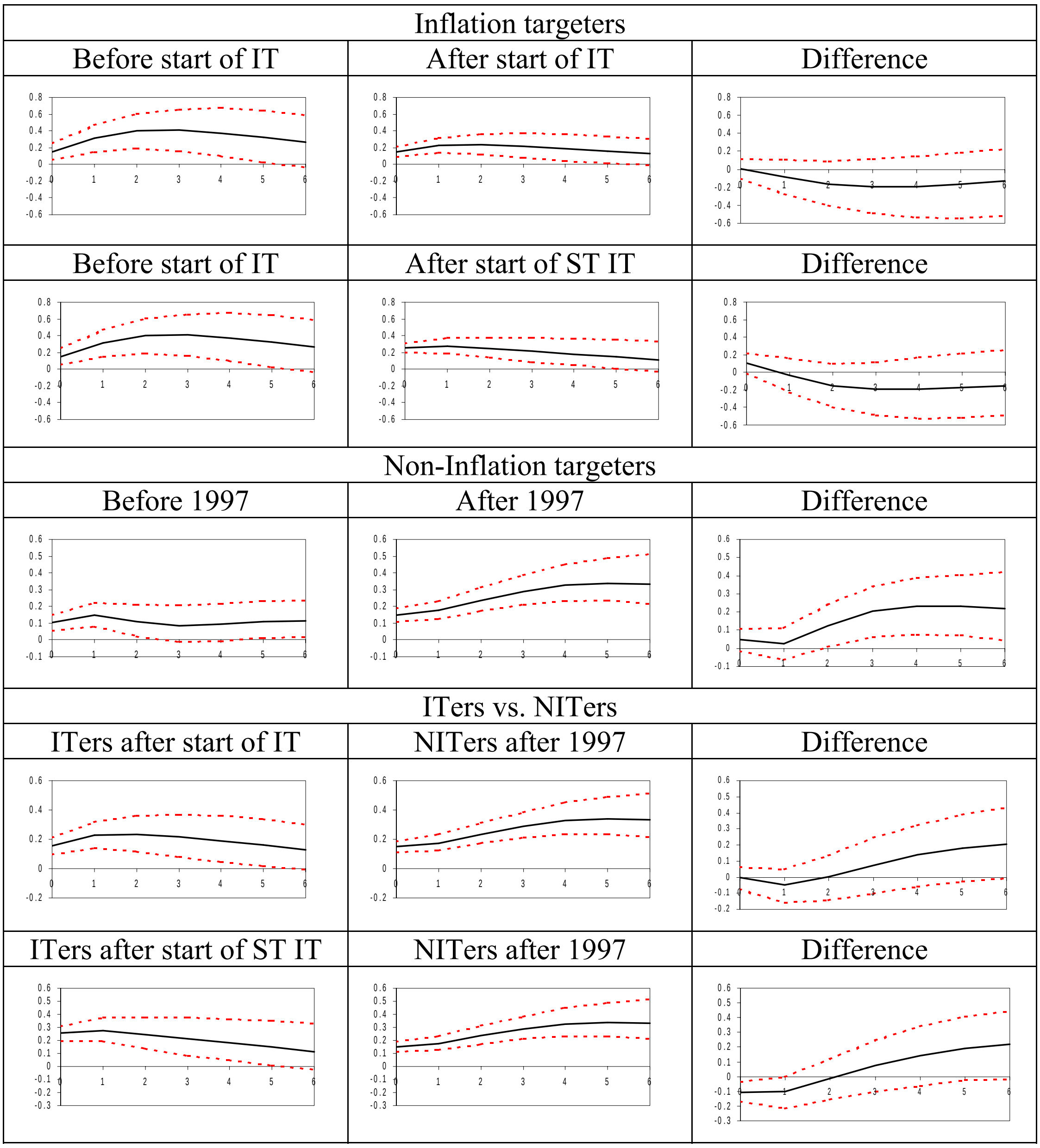
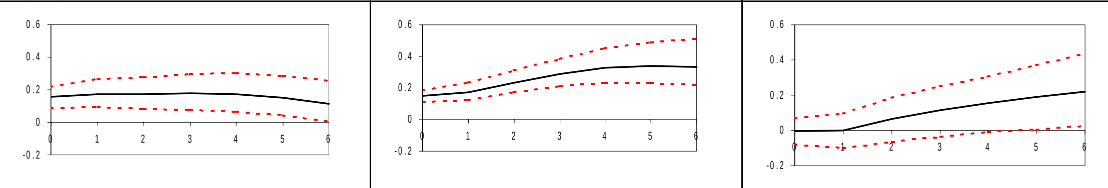
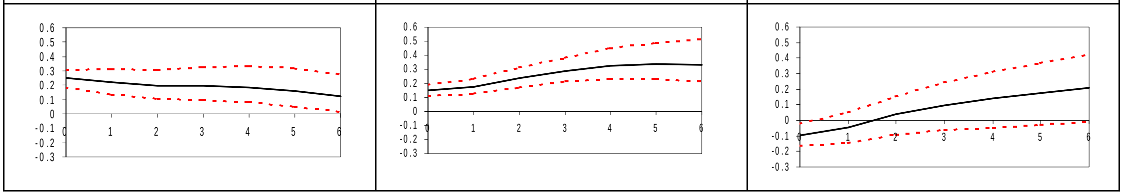


Figure 4.2
Response of Inflation to a Shock in Oil Prices, Splitting Treatment Group Sample: Industrial and Emerging Economies

4.2.a. Industrial Economies (IE's)

(IE) ITers vs. NITers		
(IE) ITers after start of IT	NITers after 1997	Difference
		
(IE) ITers after start of ST IT	NITers after 1997	Difference
		

4.2.b. Emerging Economies (EE's)

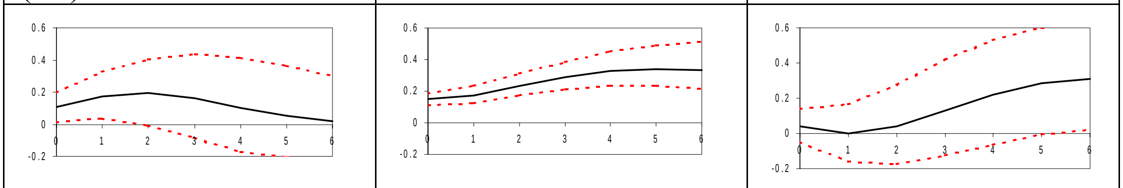
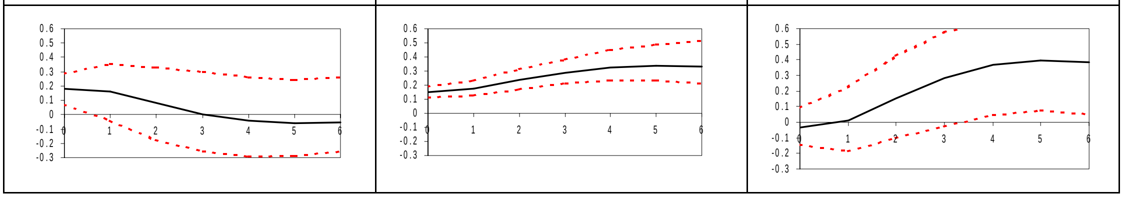
(EE) ITers vs. NITers		
(EE) ITers after start of IT	NITers after 1997	Difference
		
(EE) ITers after start of ST IT	NITers after 1997	Difference
		

Figure 4.3
Response of Inflation to a Shock in the Exchange Rate, Full Treatment Group (ITers) Sample

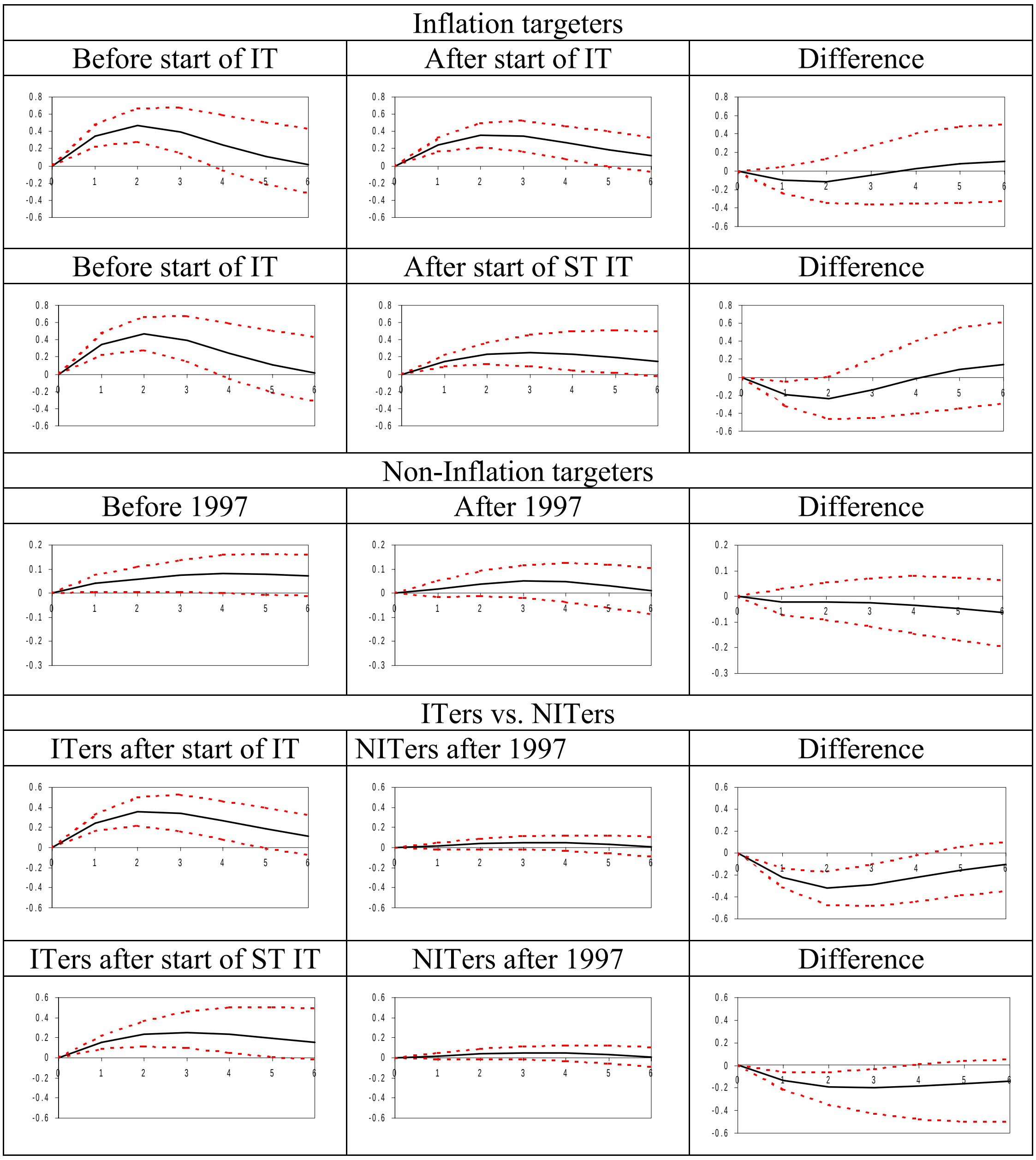
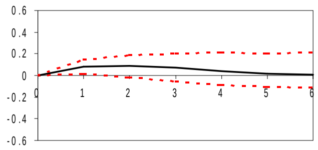
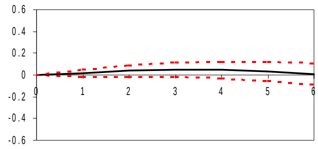
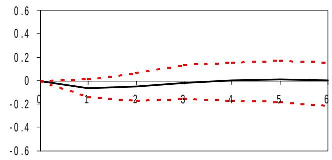
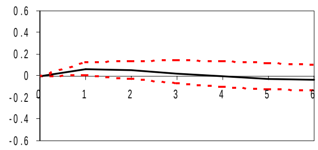
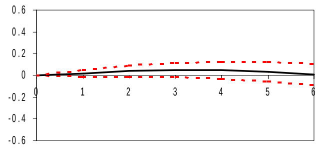
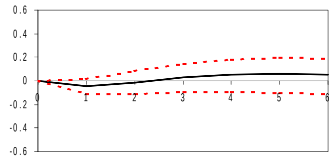


Figure 4.4
Response of Inflation to a Shock in the Exchange Rate, Splitting Treatment Group Sample: Industrial and Emerging Economies

4.4.a. Industrial Economies (IE's)

(IE) ITers vs. NITers		
(IE) ITers after start of IT	NITers after 1997	Difference
		
(IE) ITers after start of ST IT	NITers after 1997	Difference
		

4.4.b. Emerging Economies (EE's)

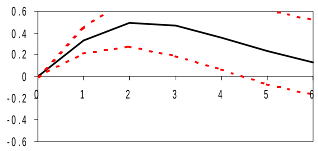
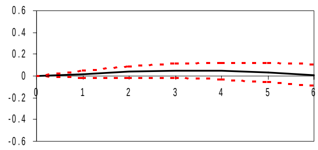
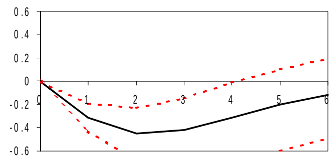
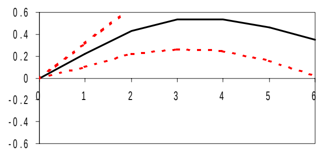
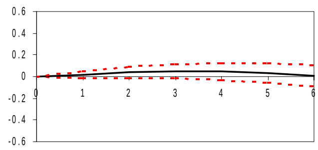
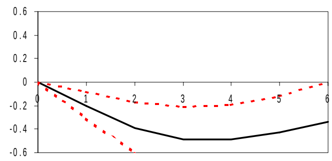
(EE) ITers vs. NITers		
(EE) ITers after start of IT	NITers after 1997	Difference
		
(EE) ITers after start of ST IT	NITers after 1997	Difference
		

Figure 4.5
Response of the Domestic Interest Rate to a Shock in the International Interest Rate, Full Treatment Group (ITers) Sample

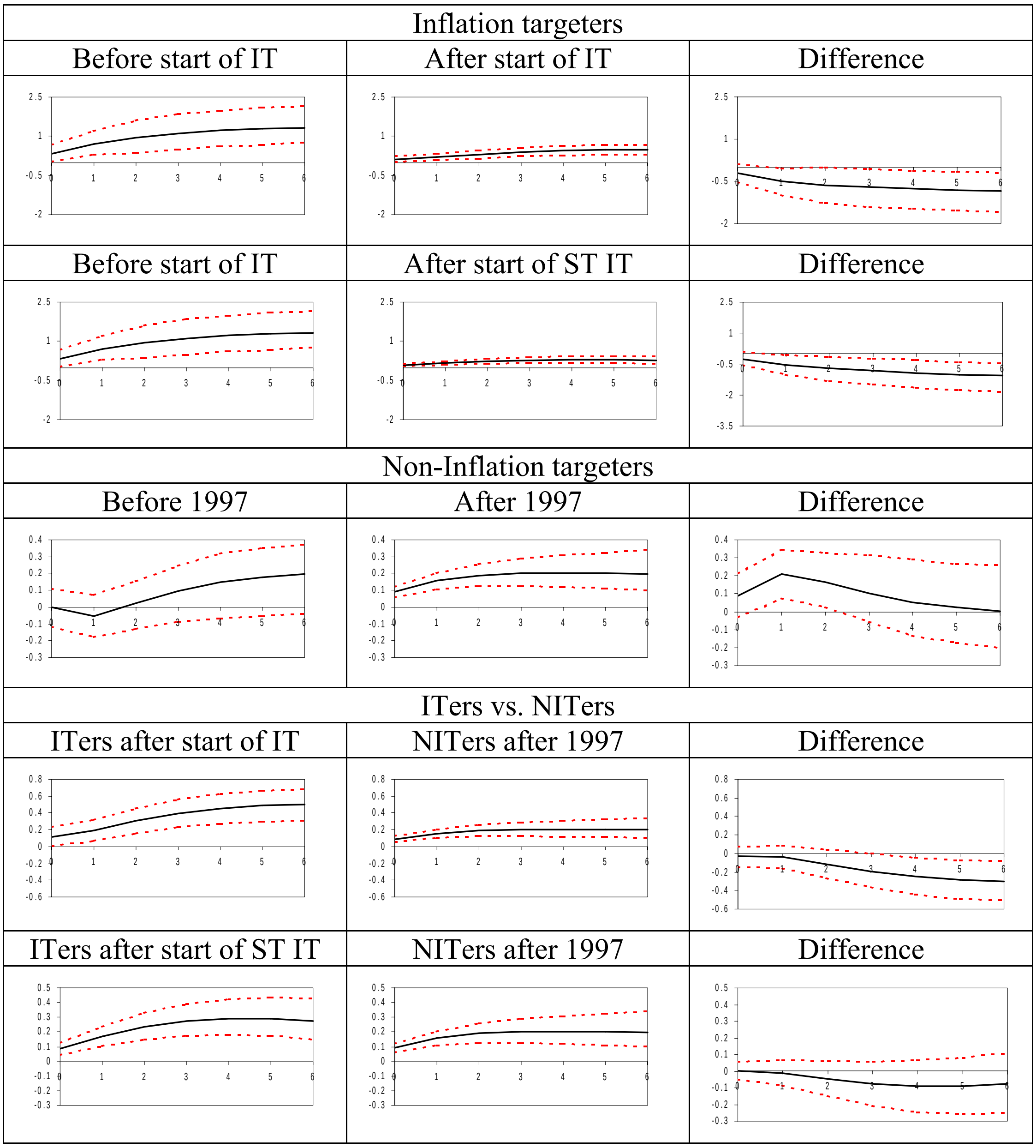
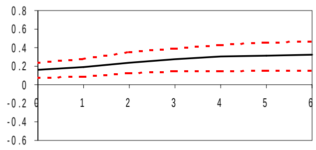
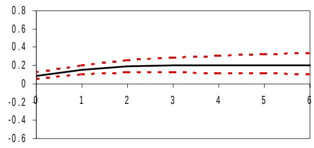
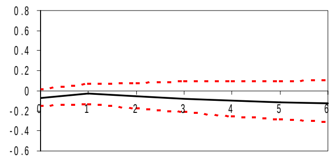
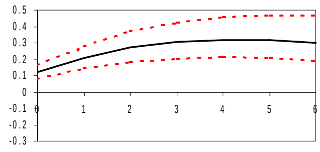
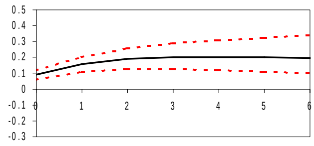
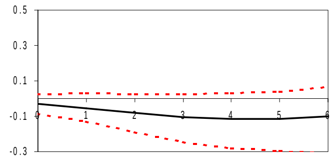


Figure 4.6
Response of the Domestic Interest Rate to a Shock in the International Interest Rate, Splitting Treatment Group Sample: Industrial and Emerging Economies

4.6.a. Industrial Economies (IE's)

<table>
<tr><th colspan="3">(IE) ITers vs. NITers</th></tr>
<tr><td>(IE) ITers after start of IT</td><td>NITers after 1997</td><td>Difference</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>(IE) ITers after start of ST IT</td><td>NITers after 1997</td><td>Difference</td></tr>
<tr><td></td><td></td><td></td></tr>
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4.6.b. Emerging Economies (EE's)

<table>
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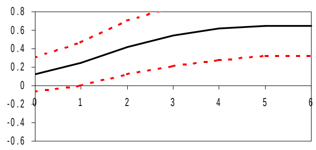
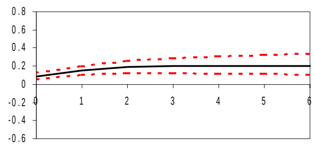
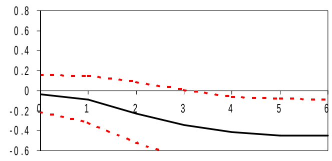
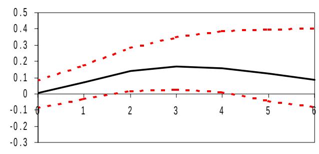
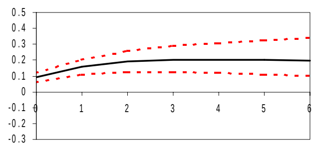
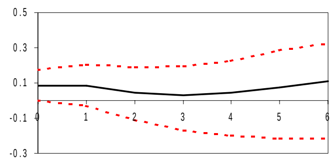
<tr><td>(EE) ITers after start of IT</td><td>NITers after 1997</td><td>Difference</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>(EE) ITers after start of ST IT</td><td>NITers after 1997</td><td>Difference</td></tr>
<tr><td></td><td></td><td></td></tr>
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Table 5.1
Performance and Policy Efficiency Changes over Time and between ITers and NITers

Group 1	L1	E1	S1	Group 2	L2	E2	S2	L2-L1	E2-E1	S2-S1
ITers before IT	8.302	2.931	5.371	*ITers after IT*	4.485	2.048	2.436	-3.817	-0.882	-2.935
(as % of L)		*35.3*	*64.7*			*45.7*	*54.3*		*23.1*	*76.9*
ITers before IT	8.302	2.931	5.371	*Stationary ITers*	2.007	0.780	1.227	-6.296	-2.151	-4.145
(as % of L)		*35.3*	*64.7*			*38.9*	*61.1*		*34.2*	*65.8*
NITers before 1997	0.869	0.129	0.740	*NITers after 1997*	0.571	0.268	0.303	-0.298	0.139	-0.437
(as % of L)		*14.9*	*85.1*			*47.0*	*53.0*		*-46.9*	*146.9*
ITers after IT	4.485	2.048	2.436	*NITers after 1997*	0.571	0.268	0.303	-3.913	-1.780	-2.134
(as % of L)		*45.7*	*54.3*			*47.0*	*53.0*		*45.5*	*54.5*
of which:										
Emerging ITers	6.657	3.098	3.559	*NITers after 1997*	0.571	0.268	0.303	-6.086	-2.829	-3.257
(as % of L)		*46.5*	*53.5*			*47.0*	*53.0*		*46.5*	*53.5*
Industrial ITers	1.752	0.786	0.966	*NITers after 1997*	0.571	0.268	0.303	-1.181	-0.517	-0.663
(as % of L)		*44.9*	*55.1*			*47.0*	*53.0*		*43.8*	*56.2*
Stationary ITers	2.007	0.780	1.227	*NITers after 1997*	0.571	0.268	0.303	-1.435	-0.511	-0.924
(as % of L)		*38.9*	*61.1*			*47.0*	*53.0*		*35.6*	*64.4*
of which:										
Emerging Stationary ITers	3.547	1.850	1.697	*NITers after 1997*	0.571	0.268	0.303	-2.976	-1.581	-1.395
(as % of L)		*52.1*	*47.9*			*47.0*	*53.0*		*53.1*	*46.9*
Industrial Stationary ITers	1.358	0.524	0.834	*NITers after 1997*	0.571	0.268	0.303	-0.787	*-0.3*	*-0.5*
(as % of L)		*38.6*	*61.4*			*47.0*	*53.0*		*32.5*	*67.5*

Figure 5.1
Efficiency Frontier and Performance Point

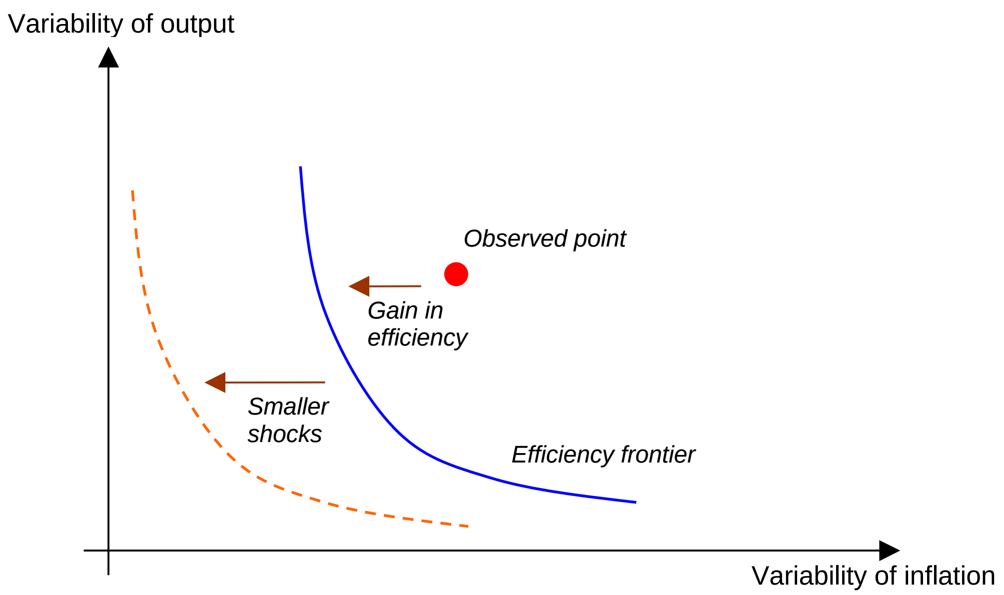


Figure 5.2
Estimated Efficiency Frontiers and Observed Performance Points: ITers before and after IT

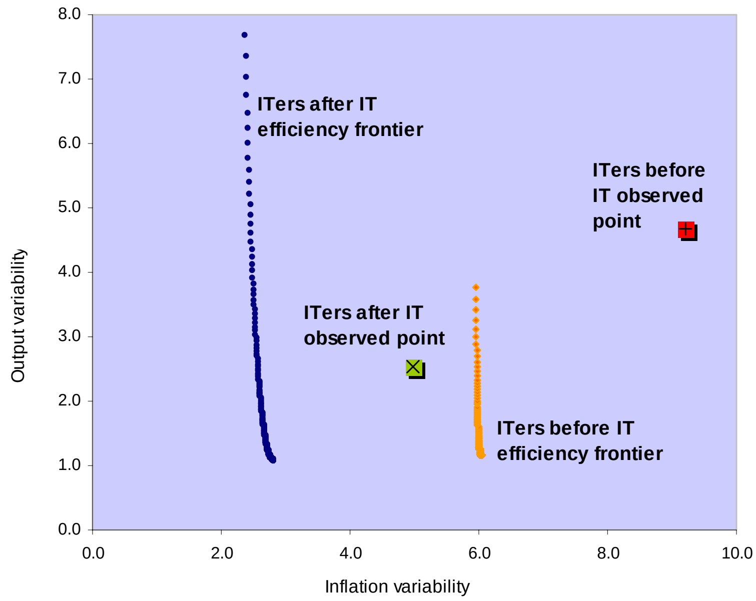


Figure 5.3
Estimated Efficiency Frontiers and Observed Performance Points: ITers before IT and Stationary-Target ITers

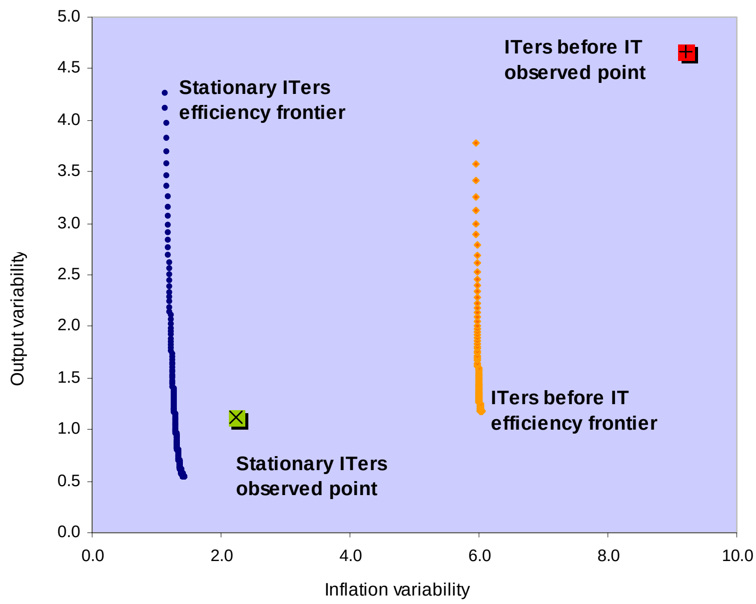


Figure 5.4
Estimated Efficiency Frontiers and Observed Performance Points: NITers before 1997 and since 1997

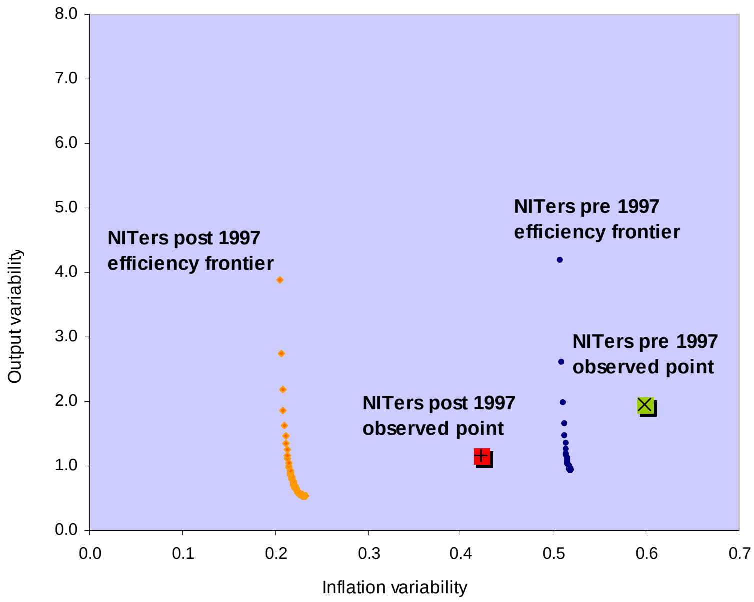


Figure 5.5a
Estimated Efficiency Frontiers and Observed Performance Points: ITers and NITers since 1997

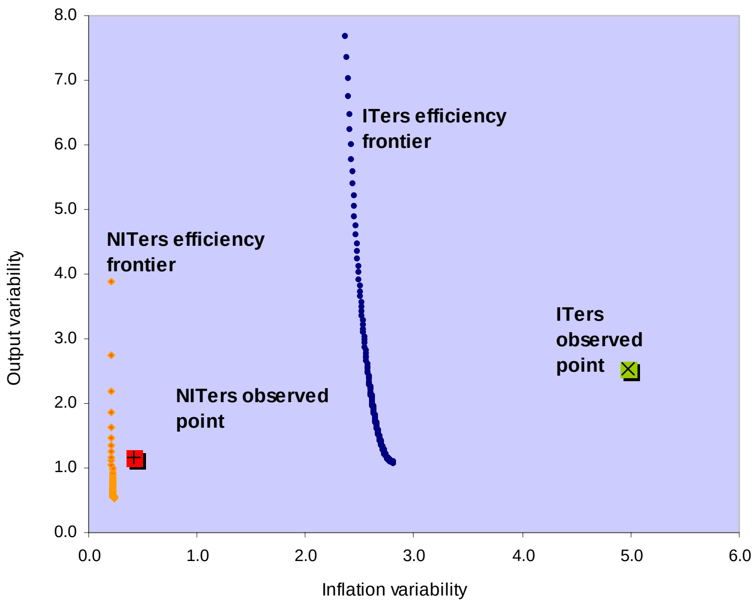


Figure 5.5b
Estimated Efficiency Frontiers and Observed Performance Points: Emerging ITers and NITers since 1997

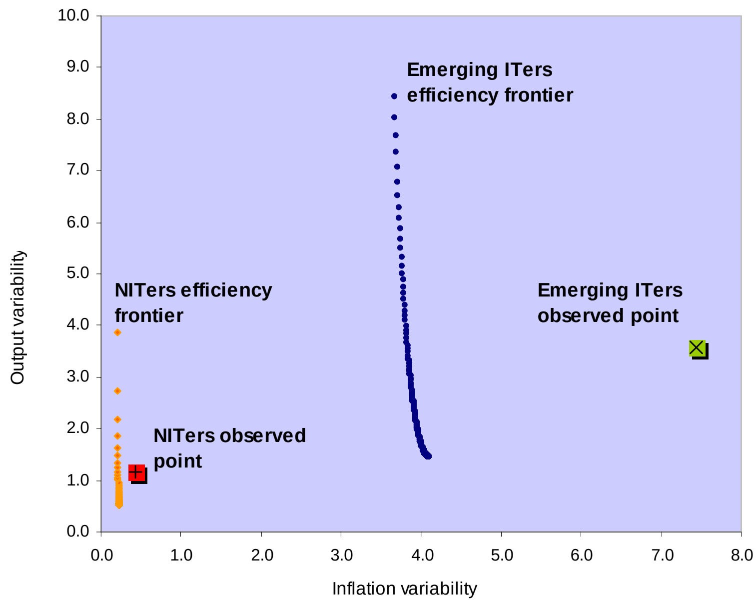


Figure 5.5c
Estimated Efficiency Frontiers and Observed Performance Points: Industrial ITers and NITers since 1997

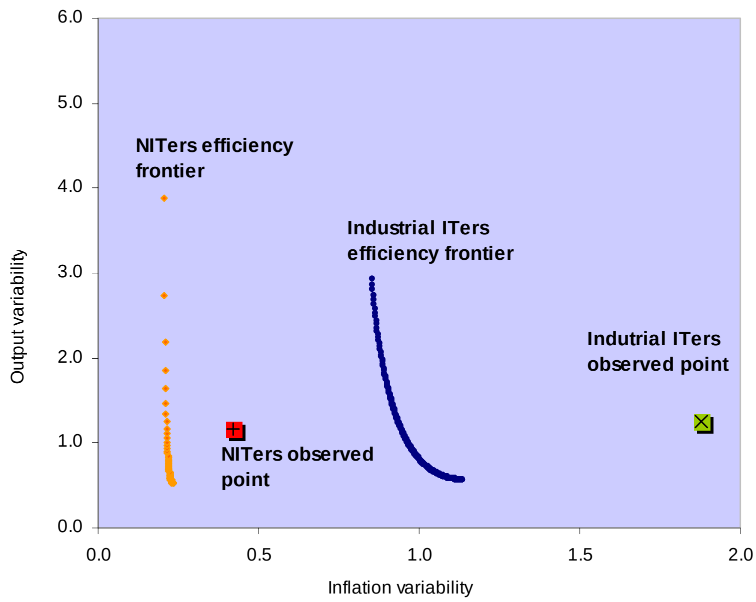


Figure 5.6a
Estimated Efficiency Frontiers and Observed Performance Points: Stationary ITers and NITers since 1997

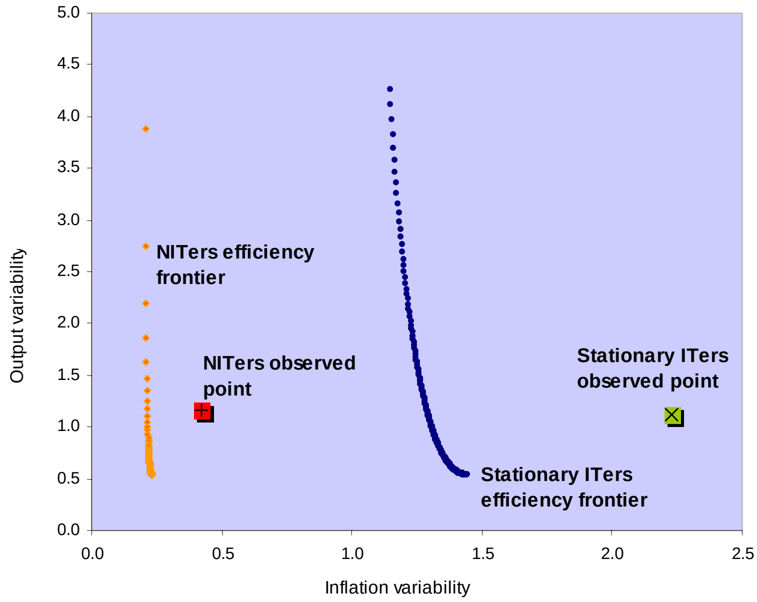


Figure 5.6b
Estimated Efficiency Frontiers and Observed Performance Points: Emerging Stationary ITers and NITers since 1997

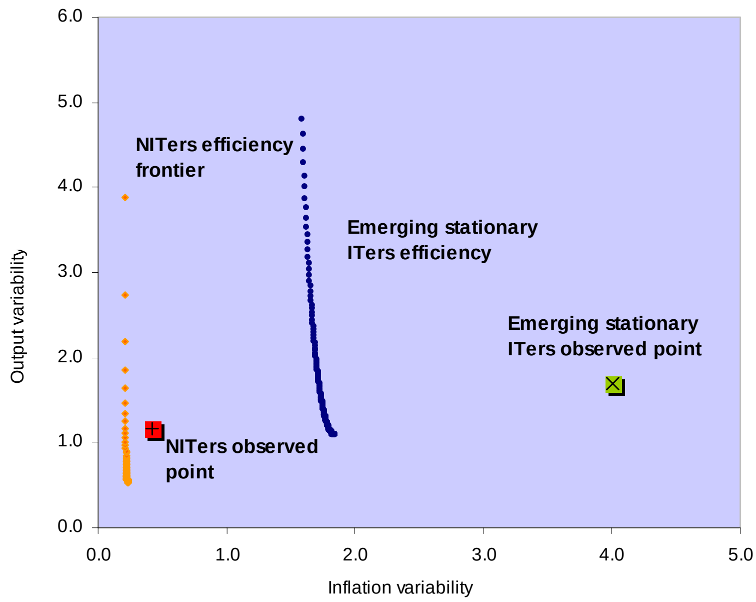


Figure 5.6c
Estimated Efficiency Frontiers and Observed Performance Points: Industrial Stationary ITers and NITers since 1997

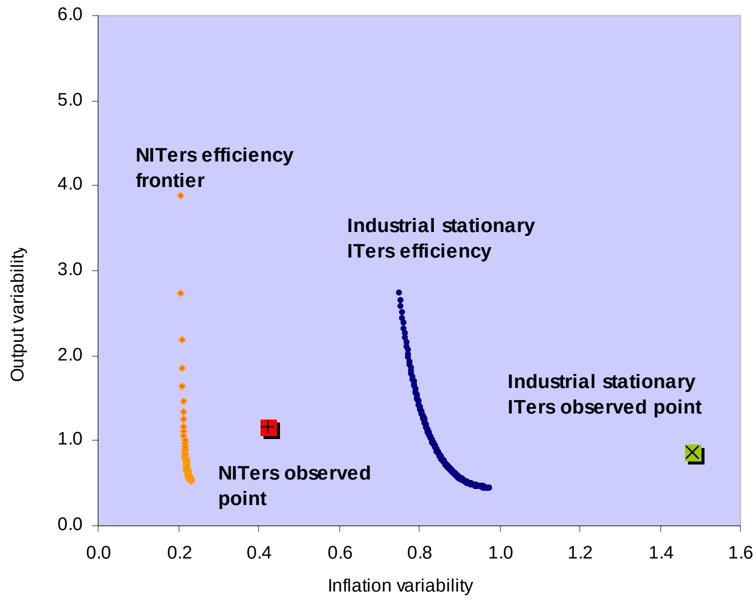


Table 6.1
Absolute Deviations of Inflation Rate from Inflation Target or from Inflation Trend

	ID1			ID2		
	Percentile			Percentile		
	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
Non-Inflation Targeters	0.24	0.54	1.20	0.24	0.54	1.20
Always NITers (13)	0.18	0.36	0.67	0.18	0.36	0.67
Iters before adopting IT (21)	0.41	1.12	2.38	0.41	1.12	2.38

Note: For IT 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 NIT countries, ID1 and ID2 are defined as the absolute deviations of actual inflation from its HP trend. Number of countries within parenthesis.
Source: Author's computations based on OECD Main Economic Indicators, IMF and country central bank data.

Table 6.2
Inflation Deviations from Target or Trend in IT and NIT Countries
(Panel Instrumental Variables Estimates, Dependent Variable: Absolute Inflation Deviations ID1)

	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)***
IT	-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 rate *(t-4)*]	0.033	0.020	0.035	0.030	0.034
	(0.014)**	(0.197)	(0.009)***	(0.063)*	(0.011)**
Stationary ITs			-0.133	-0.348	
			(0.257)	(0.489)	
Converging ITs			-0.232	-0.118	
			(0.065)*	(0.924)	
Emerging ITs					-0.245
					(0.039)**
Industrial ITs					-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)
Observations	1861	1375	1865	1391	1861
Number of Country	33	33	33	33	33

Note: p values in parentheses. The instrument set includes lagged values of inflation deviation from target, it dummy, NER depreciation, the output gap and contemporaneous observations of oil gap and FED rate. For the definition of inflation deviation measure ID1 see section 2 and the note of table 6.1.
Control group 1: All NITers including pre-IT observations of subsequent IT countries.
Control group 2: All NITers that never had IT in place.
* significant at 10%; ** significant at 5%; *** significant at 1%

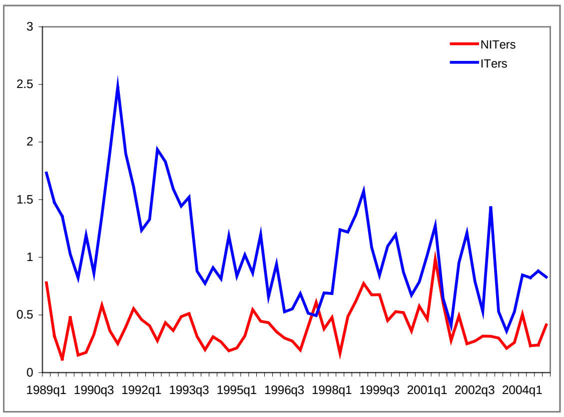
Table 6.3
Inflation Deviations from Target or Trend in IT and NIT Countries
(Panel Instrumental Variables Estimates, Dependent Variable: Absolute Inflation Deviations ID2)

	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)***
IT	-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 rate *(t-4)*]	0.026	0.005	0.026	0.010	0.026
	(0.034)**	(0.716)	(0.031)**		(0.033)**
Stationary ITs			-0.264	-0.408	
			(0.012)**	(0.408)	
Converging ITs			-0.258	-0.121	
			(0.023)**	(0.907)	
Emerging ITs					-0.280
					(0.008)***
Industrial ITs					-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)
Observations	1861	1390	1865	1391	1861
Number of Country	33	33	33	33	33

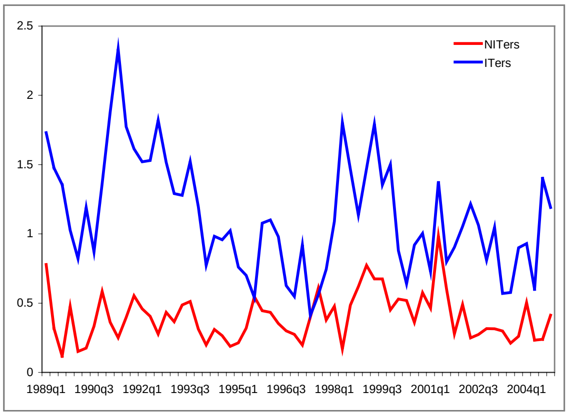
Note: p values in parentheses. The instrument set includes lagged values of inflation deviation from target, it dummy, NER depreciation,
Control group 1: All NITers including pre-IT observations of subsequent IT countries.
Control group 2: All NITers that never had IT in place.
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 6.1
Median Absolute Deviations of Inflation Rate from Inflation Target or From Trend in ITers and NITers, 1989-2004

ID1



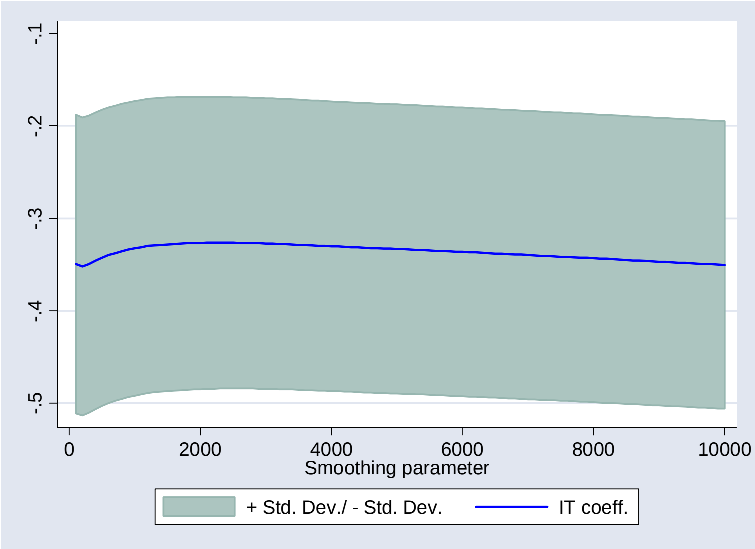
ID2



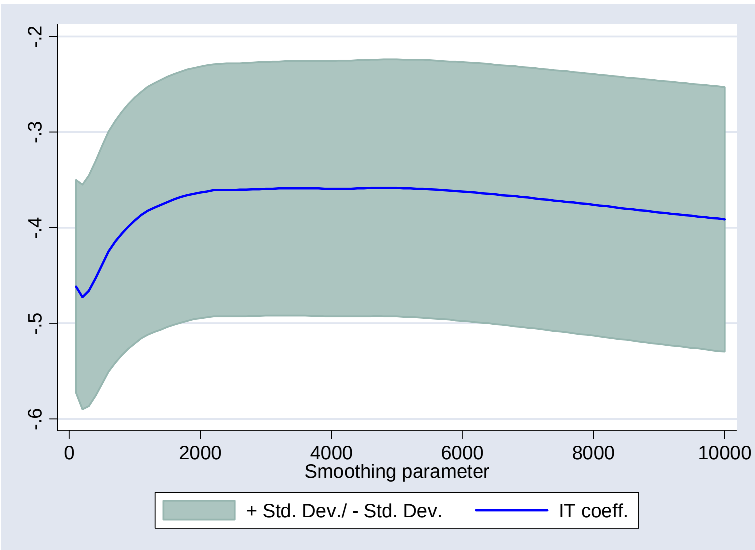
Note: For definitions of inflation deviation measures ID1 and ID2 see section 2 and the note of table 6.1.

Figure 6.2
Estimated Coefficient of Inflation Targeting for Alternative Values of the HP Filter Smoothing Parameter

ID1



ID2



Note: reported coefficients correspond to the IT dummy coefficients corresponding to the regressions reported in column 1 of Tables 6.2 and 6.3.