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ASSESSING INFLATION TARGETING AFTER A DECADE OF WORLD EXPERIENCE

VITTORIO CORBO[a,*], OSCAR LANDERRETCHE[b], and KLAUS SCHMIDT-HEBBEL[c]
[a] *Pontificia Universidad Católica de Chile*
[b] *Massachusetts Institute of Technology, USA*
[c] *Central Bank of Chile, Chile*

ABSTRACT

Ten years of inflation targeting worldwide provide valuable lessons. Inflation targeters (ITers) have been very successful in meeting their inflation targets (ITs). Industrial output sacrifice during inflation stabilization and industrial output volatility has frequently been lowered after IT adoption. ITers have consistently reduced inflation forecast errors after IT adoption. The influence of price and output shocks on the behaviour of inflation and output gaps has changed much more strongly among ITers than in non-targeting industrial countries in the course of the 1990s. IT has played a role in strengthening the effect of forward-looking expectations on inflation, hence weakening the weight of past inflation inertia. Central bankers' aversion to inflation is, on average, not different among ITers in comparison to NITers but has risen in emerging-country ITers. ITers have gradually reaped a credibility gain, allowing them to achieve their targets with smaller changes in interest rates in the late 1990s than the changes that were required in the early 1990s.

KEY WORDS: inflation targeting; monetary policy; Latin America

JEL CODE: E52; E58

1. INTRODUCTION

Inflation targeting (IT) is the new kid on the block of monetary regimes. Since IT was first adopted by New Zealand and Chile in 1990, a growing number of industrial and developing countries followed, anchoring their monetary policy to explicit targets for inflation.

Does adoption of IT make a difference? The experience with IT is certainly very recent, and while IT countries have reduced their inflation levels, more careful evidence provides a more cautious picture. Bernanke *et al.* (1999) show that adoption of IT did not make a difference regarding the cost and speed of price stabilization. Cecchetti and Ehrmann (2000) show evidence that, on average, IT countries exhibit degrees of inflation aversion that are not higher than those of non-targeters.

However, a large number of questions on the results of inflation targeting remain open. First, how successful have countries been in reducing inflation? Second, how costly has been disinflation under IT? Third, does IT improve the ability to predict inflation? Fourth, does the behaviour of the macroeconomy change under IT? Fifth, does IT change central bank aversion toward inflation? Sixth, does IT change central bank behaviour? Seventh, what is the transmission mechanism of IT? This paper addresses the latter questions by conducting a wide empirical search of the features and effects of IT, by comparing the performance of countries with and without inflation targets.

*Correspondence to: Vittorio Corbo, Pontificia Universidad Católica de Chile, Vicuña MacKenna 4860, Macul, Santiago, Chile. E-mail: vcorbo@rdc.cl.

Section 2 introduces the sample of inflation targeters used in this paper and compares their performance to that of other country groups, focusing on their success in meeting inflation targets, sacrifice ratios, and output volatility. Section 3 investigates if IT improves the ability to predict inflation by studying differences in VAR structures between inflation targeters and non-targeters. Section 4 studies if the behaviour of the macroeconomy changes under IT. Section 5, drawing on the methodology of Cecchetti and Ehrmann (2000), analyses if central banks' degree of aversion toward inflation is different for targeters and non-targeters. Section 6 studies if IT changes central bank behaviour. Section 7 summarizes the main conclusions.

2. ARE INFLATION TARGETERS DIFFERENT FROM NON-TARGETERS?

Recent books and articles describe the design features and general results of inflation targeting (IT) in the small but quickly growing number of countries that have adopted inflation targeting (IT) since 1990.[1] In this section we complement the preceding work by describing the sample of inflation targeters and comparing their performance to that of other country groups. We focus in particular on their inflation performance and success in meeting their targets, as well as their output sacrifice and output volatility.

2.1. Who targets?

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

While there is broad consensus in the literature about the latter general definition of IT, it is more controversial to apply this definition to come up with an empirically relevant sample of IT experiences. The reason for disagreement on sample selection and IT dating is that IT adoption has been more evolutionary than revolutionary. Most countries have adopted gradually all bells and whistles of this new monetary framework, learning over time and from other countries what defines a 'full-fledged' IT framework.

According to Schaechter *et al.* (2000), there have been 13 'full-fledged' IT experiences in the world until February 2000: Australia, Brazil, Canada, Chile, the Czech Republic, Finland, Israel, New Zealand, Poland, South Africa, Spain, Sweden, and the United Kingdom. Of the latter, Finland and Spain abandoned IT in January 1999 when they joined the European Monetary Union (EMU). We follow Schaechter *et al.* in their country classification (but not always in dating the start of IT experiences). However, we add two recent newcomers (Korea and Thailand) to their 13 countries, hence including 15 'full-fledged' IT country experiences until August 2000.

For our empirical analysis conducted for the 1980–99 period, we introduce three country groups (Table 1). Nine countries that have had IT in place dating back at least to 1995 comprise group 1 (called ITers). This group is divided into two sub-samples: two emerging countries that are inflation–transition ITers (in the sense that they started IT at inflation levels substantially above stationary levels: Chile and Israel), and seven industrial countries that are stationary ITers (in the sense that they started IT at inflation levels close to stationary levels): Australia, Canada, Finland, New Zealand, Spain, Sweden, and the United Kingdom.

Group 2 is composed of eight emerging economies on their way to IT during the 1990s, i.e. countries that have adopted IT either recently and/or have, as of today, a partial IT framework in place. These are Brazil, Colombia, Korea, Mexico, and South Africa. From the vantage-point of their transition towards inflation targeting during the 1990s we call them potential inflation targeters (PITers).[2]

Group 3—a set of control countries—is composed of 10 industrial economies countries that are not ITers: Denmark, France, Germany, Indonesia, Italy, Japan, the Netherlands, Norway, Portugal, Switzerland, and the USA. These countries have no explicit inflation target in place or, in the case of

Table 1. Country sample of inflation targeters (ITers), potential inflation targeters (PITers), and non-inflation targeters (NITers) during the 1990s

ITers		Potential ITers	Non-ITers
Transition ITers	Stationary ITers		
Chile	Australia	Brazil	Denmark
Israel	Canada	Colombia	France
	Finland	Mexico	Germany
	New Zealand	Korea	Indonesia
	Spain	South Africa	Italy
	Sweden		Japan
	United Kingdom		Netherlands
			Norway
			Portugal
			Switzerland
			United States

Figure 1. Inflation at adoption of inflation targeting framework in 14 countries: 1988–2000 (Inflation attained one quarter before adopting IT). *Source*: Authors' calculations based on data from IFS, country sources, and Schaechter *et al.* (2000).

EMU members, have adopted the euro after targeting their exchange rates to the deutschmark for most of the 1990s.[3] We label this control group non-inflation targeters (NITers).

Figure 1 depicts adoption dates and inflation rates at adoption of the 14 countries that have had IT experiences—seven (current) ITers, two (former) ITers, and five PITers as of August 2000.[4] The following stylized facts are apparent from inspection. Only five industrial countries had IT in place after 1998, as Sweden and Spain abandoned IT when they entered EMU. After early adoption by Chile and Israel, 6 years passed before additional emerging economies joined the club. However five additional members have been added since 1998.

One salient feature of the international IT experience is that many emerging countries have adopted IT when they were still at inflation levels well above stationary inflation rates. In Chile and Israel inflation

Table 2. Alternative measures of initial disinflation in inflation targeting countries

	$(t-1;\ t+1)$	$(t-2;\ t+1)$	$(t-3;\ t+1)$
Australia	0.9	−1.3	−5.4
Brazil	−3.2	−6.9	−15.8
Canada	−3.3	−3.5	−2.5
Colombia	−17.5	−16.0	−17.3
Chile	−10.6	−1.6	0.8
Finland	−1.5	−3.0	−5.0
Israel	−8.1	−6.2	−9.3
Korea	−3.6	−4.1	−3.7
Mexico	−8.7	−13.4	−27.2
New Zealand	−5.8	−4.7	−14.1
Spain	−1.2	−1.0	−2.4
Sweden	−0.1	−7.1	−8.3
South Africa	−1.4	−3.1	−4.8
United Kingdom	−1.3	−3.9	−7.0
Average	**−4.4**	**−5.4**	**−8.7**

Note: Projected inflation was used for South Africa, Brazil, Colombia, and Mexico.
Source: Authors' calculations based on data from IFS and JP Morgan.

stood at 29% and 19%, respectively, when adopting IT in the early 1990s. In the more recent cases of IT adoption, Colombia and Mexico had initial inflation rates of 10% and 18%, respectively, Korea had initial inflation close to 5%, while in Brazil and South Africa initial inflation was close to 3%.[5] The subsequent success of emerging countries in bringing inflation toward low stationary levels is *prima facie* evidence that IT can be successfully adopted to reduce inflation from (low) double-digit levels toward low single-digit rates.

2.2. How successful have countries been in reducing inflation and meeting their targets under IT?

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

A general feature of IT is that countries prepare in adopting IT by reducing inflation around the date of IT adoption (noted as year t in Table 2). This feature is generally observed in industrial and emerging, transition and stationary, ITers and PITers. Depending on the selected period, 14 inflation targeters have reduced inflation rates, on average, by measures that range from 5.4% (between years $t-2$ and $t+1$), and 8.7% (between years $t-3$ and $t+1$). Our sample of ITers has reduced inflation on average by 5.9% (3.4%) in the period that ranges from 3 (1) years before and 1 year after IT adoption. Similar results are observed in the sample of PITers, where inflation was reduced on average by 13.8% (6.9%).

Now let's consider the speed of convergence to stationary inflation among ITers (Table 3). ITers have reached stationary inflation levels in 10 quarters on average. Among the nine ITers, Chile and Israel had the longest transition periods (36 and 24 quarters, respectively)—not surprisingly, considering their high initial inflation rates. Australia and Sweden were at the other extreme, as they adopted IT when they had already attained stationary inflation.

ITers have been successful in meeting their targets (Table 4). On average—as measured by their average relative deviation of actual annual inflation from target inflation—ITers have missed only 12 basis points, a figure that rises to 66 basis points when considering the average absolute deviation. Among the nine ITers, the UK, Chile, and Canada are closest to target while Israel, Sweden, and Finland score the highest deviations. Similar results are obtained when scaling relative and absolute deviations to annual inflation rates—a necessary correction to take care of large country differences in inflation levels during the

Table 3. Convergence to stationary inflation under inflation targeting in 14 countries: 1989–2000(1)

	Initial inflation	(Date)	Final inflation	(Date)	Quarters of convergence	Inflation change	Average inflation per quarter
ITers							
Australia	1.2	(1993.1)	1.2	(1993.1)	0	0.0	—
Canada	4.9	(1990.4)	1.6	(1992.1)	5	−3.3	−0.7
Chile	29.0	(1990.4)	2.5	(1999.4)	36	−26.5	−0.7
Finland	2.5	(1992.4)	2.0	(1993.3)	3	−0.5	−0.2
Israel	18.5	(1991.4)	1.9	(1999.4)	24	−16.7	−0.7
New Zealand	4.4	(1989.2)	2.8	(1991.2)	8	−1.6	−0.2
Spain	4.7	(1994.3)	1.6	(1997.2)	11	−3.1	−0.3
Sweden	1.8	(1992.4)	1.8	(1992.4)	0	0.0	—
United Kingdom	3.6	(1992.3)	1.8	(1993.1)	2	−1.8	−0.9
Average	**7.8**		**1.9**		**9.9**	**−5.9**	**−0.5**
Potential ITers							
Brazil(2)	8.3	(1999.4)	7.9	(2000.1)	1	−0.4	−0.4
Colombia	10.0	(1999.2)	10.6	(2000.2)	4	0.6	0.2
Korea	5.1	(1997.4)	0.7	(1999.1)	5	−2.4	−0.5
Mexico	17.6	(1998.4)	10.6	(2000.1)	5	−7.0	−1.4
South Africa	2.0	(1999.4)	2.0	(1999.4)	0	0.0	—
Average	**8.6**		**6.4**		**3.0**	**−1.8**	**−0.5**
Overall Average	**8.1**		**3.5**		**7.4**	**−4.4**	**−0.5**

(1) Convergence refers to most recent available observation. Stationary inflation for countries that do not explicitly announce a long-term inflation target is calculated as inflation attained by industrial countries (2–3%).
(2) Initial Inflation is calculated 2 quarters ahead, in order to adjust for the extraordinarily low inflation in 1999:1.
Source: Authors' calculations based on data from IFS, country sources, and Schaechter *et al*. (2000).

transition to stationary inflation. Using this alternative measurement, Israel and Spain join Canada, Chile, and the UK as the countries that were most on target, while Finland, Australia and now Sweden show the largest deviations.

2.3. *How costly has been disinflation under IT?*

It is straightforward to compute sacrifice ratios—i.e. percentage output losses per percentage unit of inflation reduction—as measures of the costs of disinflation under IT. For the period that ranges from 3 years before to 1 year after IT adoption—as represented in Table 2—sacrifice ratios are computed for GDP and industrial production, and for ITers and PITers (Table 5).[6] Among the nine ITers, the sacrifice ratio amounted to an average of 0.60 (using GDP), 6.6 (using industrial output) and 2.6 (using industrial output but excluding Chile and Spain, two large outliers). Among five PITers, the sacrifice ratio was, on average, a (negative) −0.4 when using GDP and −0.2 when using industrial production. Country dispersion is moderate when using GDP and high when using industrial production, ranging from −2.3 to 2.5 and −4.2 to 23.3 respectively.

An alternative way is to compare sacrifice ratios for disinflation periods under IT to sacrifice ratios before adopting IT in the same country group, and to comparable sacrifice ratios among PITers and NITers (Tables 6(a) and 6(b)). While there is large country variation, there does not seem to be a clear difference in GDP-based sacrifice ratios before and after IT adoption among the set of 9 ITers. Excluding outliers, average sacrifice ratios before and after IT adoption are −0.22 and 0.06, respectively. These figures are compared to the average sacrifice ratio of 0.57 recorded by NITers during disinflation periods in the 1990s and are substantially larger to the average figure of −1.84 observed among PITers (Table 6(a)).

Table 4. Annual average deviation of actual from target inflation under inflation targeting in 12 countries: 1989–2000 (various subperiods)[a]

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

[a] Relative (absolute) deviation: sum of relative deviations divided by number of periods. Relative (absolute) deviation as a ratio to current inflation: sum of relative (absolute) deviations as ratios to inflation divided by number of periods. Depending on the IT framework. Inflation target is defined as a range or as a point.
Source: Authors' calculations based on data from IFS. Country sources and Schaechter *et al*. (2000).

Table 5 Sacrifice ratios during inflation stabilization with inflation targeting in 14 countries: 1980–2000 (based on annual GDP, and quarterly industrial production data, various subperiods)[a]

ITers	GDP	Ind. output	PITers	GDP	Ind. output
Australia	1.1	3.3	Brazil	−0.2	−0.2
Canada	−2.3	−4.2	Colombia	0.2	1.8
Chile	−0.4	23.3	Korea	0.4	1.7
Finland	2.4	6.2	Mexico	−0.0	−2.7
Israel	0.6	4.6	South Africa	−2.3	−1.5
New Zealand	0.2	−2.1			
Spain	2.5	18.2			
Sweden	0.6	6.6			
United Kingdom	0.9	3.8			
Average	**0.6**	**6.6**		**−0.4**	**−0.2**

[a] Sacrifice ratios calculated as cumulative GDP variation (to a trend calculated by a Hodrick–Prescott filter) divided by inflation change between 3 years before and 1 year after IT adoption year.
Source: Authors' calculations based on data from IFS and country sources.

Table 6(a). Sacrifice ratios during inflation stabilization in 14 IT countries and 11 non-IT countries: 1980(1990)–2000 (based on annual GDP data, various subperiods)[a]

ITers			PITers		Non-ITers	
	Before	After	During 1990s		During 1990s	
Australia	−1.41	0.01	Brazil	−0.58	Denmark	0.90
Canada	−6.84	0.64	Colombia	0.00	France	−0.45
Chile	0.37	−0.7	Korea	0.15	Germany	−0.12
Finland	0.03	−4.74	Mexico	−3.06	Indonesia	2.36
Israel	0.17	−0.14	South Africa	−5.69	Italy	0.25
New Zealand	−0.67	0.22			Japan	1.46
Spain	−0.85	0.82			Netherlands	1.47
Sweden	0.08	0.22			Norway	−0.87
United Kingdom	0.75	0.02			Portugal	−0.39
					Switzerland	0.87
					United States	0.78
Average	**−0.22**[b]	**0.06**[b]		**−1.84**		**0.57**

[a]Sacrifice ratios calculated as the cumulative GDP variation (to a trend calculated by a Hodrick–Prescott filter) divided by inflation change in any disinflation period. ITers' sacrifice ratios are calculated before (since 1980) and after adopting IT framework. Outlier observations are excluded.
[b]Excluding Canada and Finland.
Source: Authors' calculations based on data from IFS and country sources.

Table 6(b). Sacrifice ratios during inflation stabilization in 14 IT countries and 11 non-IT countries: 1986(1990)–2000 (based on quarterly industrial production data. various subperiods)[a]

ITers			PITers		Non-ITers	
	Before	After	During 1990s		During 1990s	
Australia	−1.3	0.1	Brazil	0.0	Denmark	−0.8
Canada	−1.2	1.4	Colombia	−0.1	France	−1.2
Chile	−0.5	−0.6	Korea	−0.4	Germany	3.0
Finland	3.2	−4.5	Mexico	−0.6	Indonesia	−3.3
Israel	3.5	0.0	South Africa	−2.9	Italy	3.7
New Zealand	−0.2	−0.2			Japan	2.8
Spain	1.8	−4.9			Netherlands	3.7
Sweden	0.0	−2.2			Norway	−0.7
United Kingdom	−0.8	0.3			Portugal	−0.1
					Switzerland	2.0
					United States	−0.7
Average	**0.5**	**−1.2**		**−0.8**		**0.8**

[a]Sacrifice ratios calculated as the cumulative Industrial Production variation (to a trend calculated by a Hodrick–Prescott filter) divided by inflation change in any disinflation period. ITers' sacrifice ratios are calculated before (since 1986) and after adopting IT framework. Outlier observations are excluded.
Source: Authors' calculations based on data from IFS and country sources.

However, using industrial production a different result emerges. On average, sacrifice ratios after IT adoption were highly negative (−1.2) among ITers, and hence much lower than those recorded by the same country group before IT adoption (0.5), and also lower to the average sacrifice ratios observed among NITers (0.8) and PITers (−0.8). This result represents preliminary evidence suggesting that IT contributed in lowering output costs of inflation stabilization, at least when considering higher-frequency measures of industrial output (Table 6(b)).

A related result is referred to output volatility. We compare the volatility of industrial output before and after IT adoption in nine ITers and only 1 PITer (Table 7). Output volatility fell in eight of the ten countries

Table 7. Output volatility in 14 IT countries and 11 non-IT countries: 1980–2000 (based on quarterly industrial production data, various subperiods)[a]

ITers			Potential ITers			Non ITers	
	Before	After		Before	After		During 1990s
Australia	2.8	1.2	Brazil	4.8	—	Denmark	2.8
Canada	4.4	2.2	Colombia	4.5	—	France	1.6
Chile	6.2	3.1	Korea	3.6	9.4	Germany	2.4
Finland	3.1	2.5	Mexico	4.0	—	Italy	2.3
Israel	2.9	1.7	South Africa	3.2	—	Japan	3.3
New Zealand	3.4	3.1				Indonesia	1.4
Spain	2.4	1.7				Netherlands	2.2
Sweden	3.1	3.4				Norway	2.8
United Kingdom	2.4	1.3				Portugal	10.8
						Switzerland	2.8
						United States	2.3
Average	**3.4**	**2.2**		**4.2**	**9.4**		**3.2**

[a] Volatility calculated as standard deviation of industrial production variation (to a trend calculated by a Hodrick–Prescott filter).
Source: Authors' calculations based on data from IFS and country sources.

and in six of them the reduction in the standard deviation of industrial output was significant at least at the 10% level. Output volatility among ITers is similar to that observed among NITers during the 1990s.

3. DOES INFLATION TARGETING IMPROVE THE ABILITY TO PREDICT INFLATION?

This section reports country VAR models, shows differences in VAR structures between ITers and non-ITers, and compares how one-step-ahead inflation forecast errors (constructed from the country VARs) have evolved over time in the three country groups.

For the three groups of countries we have put together a database of quarterly 1980–99 variables for five relevant macroeconomic variables: industrial production (*IP*),[7] money (*M*), consumer prices (*CPI*), interest rates (*IR*), and the nominal exchange rate (*NER*). To avoid treating cointegration vectors in different countries, we specify all variables (except the interest rate) as deviations from a potentially non-stationary trend measured with a Hodrick–Prescott filter with a 1600 penalty parameter on the second derivative of the trend. Each variable is measured as the logarithmic deviation from the trend, allowing us to focus on the relationships between the stationary components of the set of macroeconomic variables. In the case of IP the resulting series is an approximation of the gap between actual and potential output and in the case of inflation the resulting series is a deviation from trend inflation.

We assume that the structure of the economy can be adequately described by a non-structural vector autoregressive simultaneous equation system. We run a comprehensive model, common to all economies, described by the stationary components of their major macroeconomic variables. The unrestricted VAR is based on five endogenous variables, ordered from more to less endogenous: *CPI*, *IP*, *M*, *NER*, *IR*. We also include two exogenous variables: international interest rates and oil prices. The ordering of the variables in the VAR assumes that the movements of the short-term interest rate are the most relatively exogenous of all the set of macroeconomic variables.[8] The VAR uses four lags and is run on a moving window of seven years for most countries. The equation of inflation in the VAR is used to generate a one-period out-of-sample forecast of inflation, which is our proxy of inflation expectations. To be able to make some robust inferences we run two types of exercises: one is for a seven-year moving window, and the other is a recursive estimation of the VAR with additional information used in every recursive estimation.

In countries that have used IT to converge to steady-state levels of inflation, inflation targets carry information on the monetary stance of the central bank. The announcement of the inflation target should be news for the market and inflation expectations should be affected by the target set by the bank. The inflation target signals how aggressive the disinflation will be during the relevant period; it acts as a coordination mechanism and a commitment device. We should expect this coordination mechanism to reduce the forecast error since agents will have a larger degree of certainty about the parameters of the economy in which they are operating.

In countries close to their steady-state levels of inflation, the inflation target carries less information than in the previous case. However, the credible commitment of the monetary authority to a numerical target may also contribute to better coordination among agents and markets. For example, announcing inflation targets may reduce the reaction of agents to inflation news or the dependence of specific prices on formal or informal indexation mechanisms, aligning the reaction of the economy to the desired reaction of the central bank.

The VAR results are used for generating inflation deviation forecasts for each country. Up to this point we are using a rolling (recursive) estimation of an inflation equation to generate inflation.[9] We use four lags in the estimation, which come from a rolling and recursive estimation of Akaike, Schwartz and Hannan–Quinn information criteria for each country.[10]

To assess the effect of the inflation-targeting regime on the formation of inflation expectations we generate the square of the forecast errors from the aforementioned VARs and average them across ITers and NITers. In order to control for the fact that high inflation forecast errors could be related to high inflation levels we divide by the trend level of inflation that we have estimated before aggregating by country.

In Figures 2(a) and 2(b) we depict average quadratic inflation forecast errors for different samples of ITers and NITers. In panels I, III and V of each figure we define the group of ITers by including each ITer only in the periods in which they had IT in place; in all other periods years they are included among NITers. However, in panels II, IV and VI we define the group of ITers by including every country that had IT in place during some period in 1990–99. Panels I and II are defined for the full country sample except Brazil and Indonesia that were found to be very clear outliers. Panels III and IV are identical to panels I and II but for Mexico and Korea, that were excluded because of high volatility during the sample period. Panels V and VI represent an even smaller sample of only industrial countries, hence excluding Israel and Chile. In all six panels the continuous lines depict ITers and the dotted lines represent NITers.

The results suggest an effect of inflation targeting on the accuracy of the forecasts. We observe consistently that countries that adopted IT have converged to levels of accuracy similar to that of non-targeters. This convergence has occurred towards 1994 and is on top of the improved accuracy observed in the group of non-targeters. The result of panel VI suggests that this convergence process has been important for non-industrial countries ITers, such as Israel, Chile, and Mexico. The results suggest that the bonus of higher accuracy (and presumably more credibility) has been reaped by countries converging to steady-state inflation levels rather than steady-state inflation targeters. Hence inflation targeters have achieved during the last decade a significant convergence of inflation expectations to their actual inflation rates over the last decade. The similarity of results reported in Figures 2(a) and 2(b) supports the robustness of this conclusion.

Most of the time-series structure of the inflation errors has been removed from the VARs on which the quadratic inflation deviation forecast errors are based. However, we still find that some time-series structure remains in the inflation series for some countries, as indicated by correlograms. Since we are not able to address this problem by including more lags, we resort to filtering the resulting forecast errors by the time-series structure suggested by the correlograms, recalculating the group averages of quadratic inflation deviation forecast errors for targeters and non-targeters. The corresponding results (Figures 3(a) and 3(b)) show that the preceding result of panels I to V are maintained while the result of panel VI provides evidence of inflation expectations convergence. While in the previous panel VI (in Figures 2(a) and 2(b)) industrial-country ITers exhibited a similar reduction of forecast errors than NITers over the 1990s, now panel VI (in Figures 3(a) and 3(b)) shows a clear convergence of ITers to NITers, as the latter had already low forecast errors since the beginning of the 1990s.

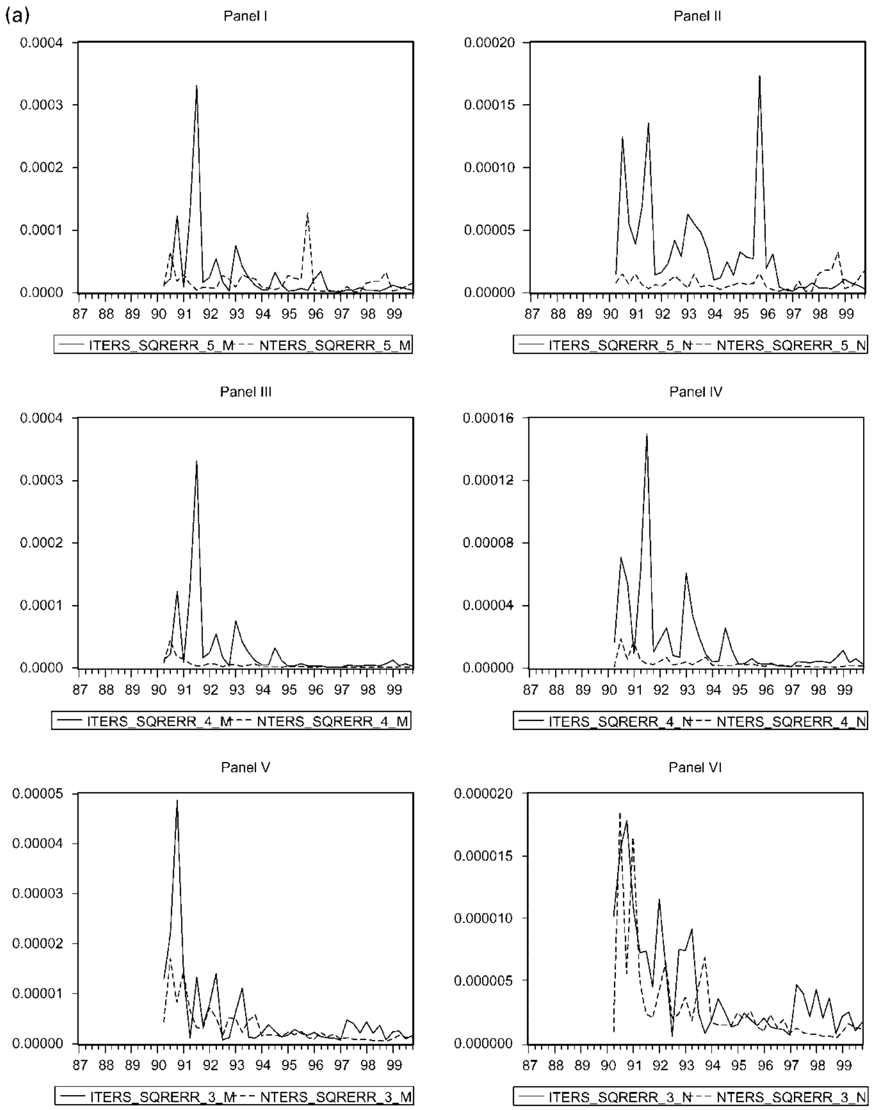

Figure 2. (a) Average quadratic errors of inflation deviation forecasts for inflation targeting and non-targeting countries (obtained from out-of-sample forecasts of a rolling VAR and divided by the level of trend inflation): 1980–99, quarterly data. (b) Average quadratic errors of inflation deviation forecasts for inflation targeting and non-targeting countries (obtained from out-of-sample forecasts of a recursive VAR and divided by the level of trend inflation): 1980–99, quarterly data.

4. DOES THE BEHAVIOUR OF THE MACROECONOMY CHANGE UNDER IT?

In order to assess if IT has changed the structure of the economies and their response to shocks, we report dynamic variance decomposition results for the country VARs that we used in the preceding section. The dynamic simulation is performed by reporting the average share of the orthogonalized innovation of one variable in the variance of another variable using the estimated VAR parameters and the orthogonalized components of each of the endogenous variables.[11]

The variance decomposition provides information about the relative importance of each random innovation to each variable in the VAR, describing the reduced-form effects and tradeoffs that are present in an economy. If the VAR model is an adequate description of the economy, it will provide the

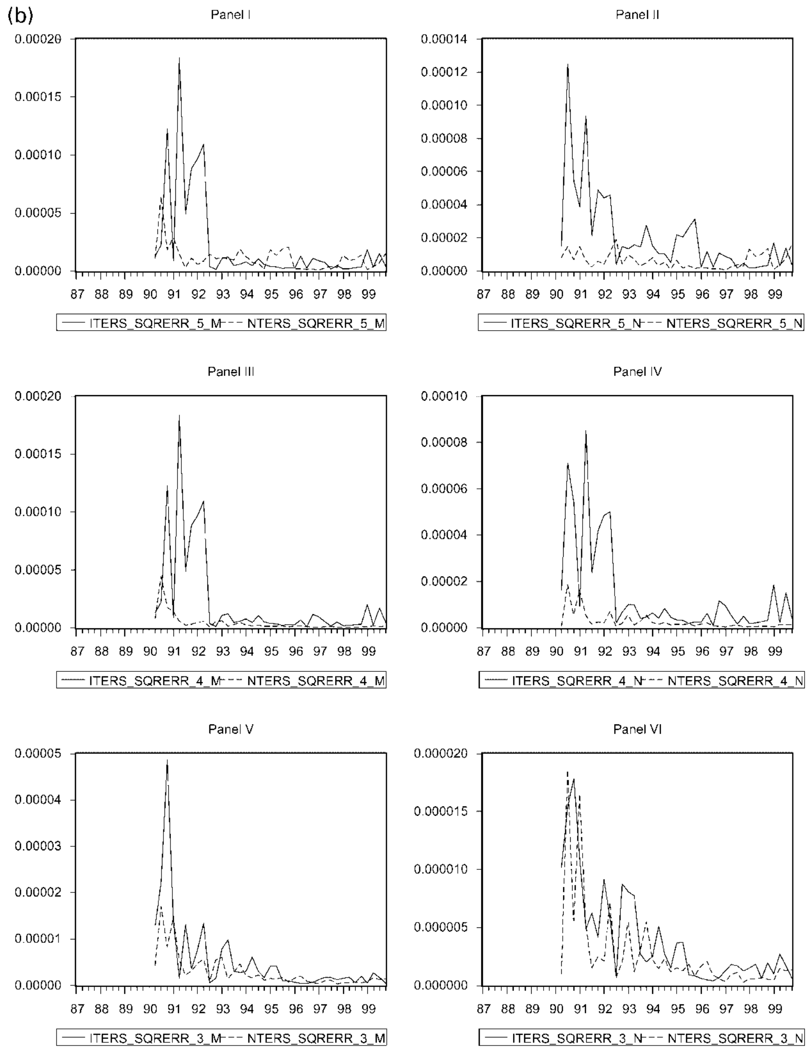

Figure 2. (Continued)

reduced-form response of the macroeconomy that combines the interplay of private and public sector actions, including monetary policy reactions of the central bank.

We simulate dynamic variance decompositions for the rolling country VARs reported in the preceding section.[12] We report some results as aggregates for samples of IT countries and non-IT countries while others we report separately for each country.

The results for two sample selections are reported for both the complete set of 25 countries[13] (Figure 4(a)) and for an alternative smaller set of industrial countries[14] (Figure 4(b)). The figures show the shares of orthogonalized innovations in inflation and the output gap in the variance of inflation innovations, considering both own and cross-innovations. Each figure reports separately the dynamic variance decomposition effects for the four different lags included in the VARs. The results for rolling VARs are reported for fixed windows of 40 quarters (depending on availability of data per country VAR), starting with 1980.1–1989.4 (reported as the first observation in each figure) and ending with 1990.1–1999.4 (reported as the last observation).

The results show revealing commonalties and differences across country groups and over time. An innovation in the first inflation lag (reflecting first-order inflation persistence) shows some increase over

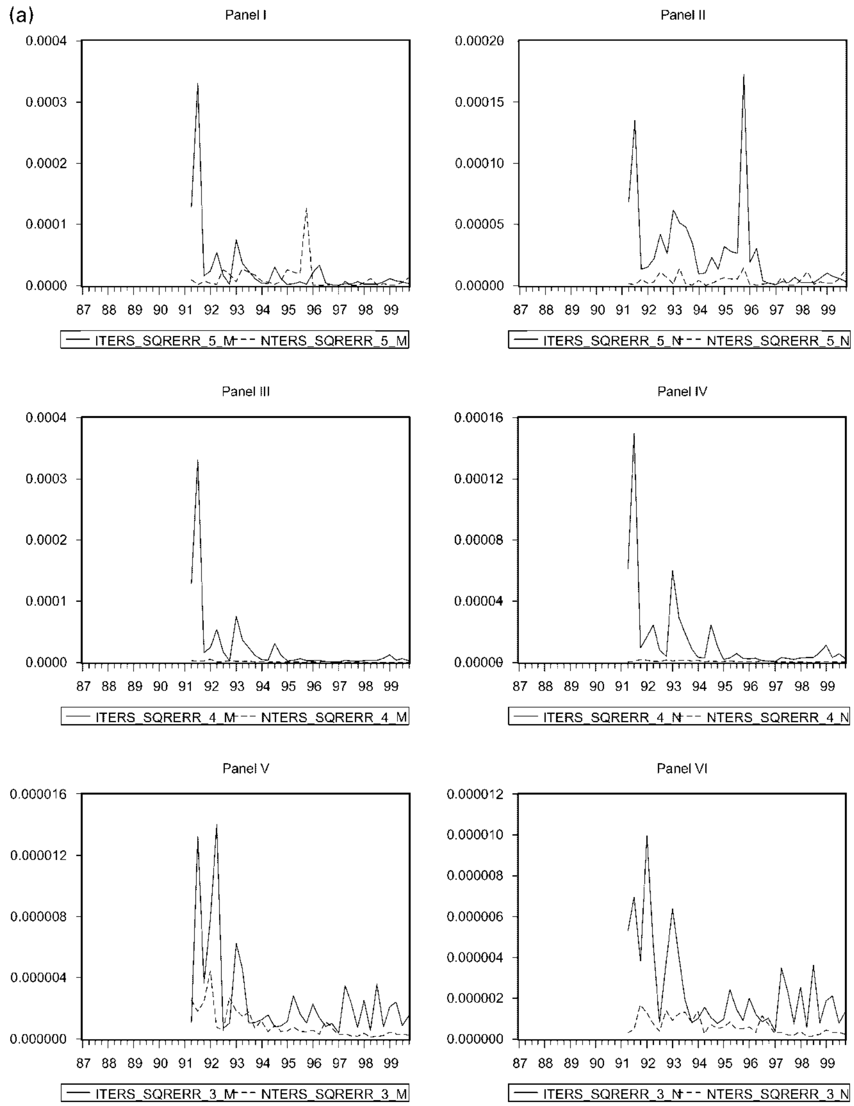

Figure 3. (a) Average quadratic errors of inflation deviation forecasts for inflation targeting and non-targeting countries (obtained from out-of-sample forecasts of a rolling VAR with errors filtered for remaining structure and divided by the level of trend inflation): 1980–99, quarterly data. (b) Average quadratic errors of inflation deviation forecasts for inflation targeting and non-targeting countries (obtained from out-of-sample forecasts of a recursive VAR with errors filtered for remaining structure and divided by the level of trend inflation): 1980–99, quarterly data.

time but not much difference across country groups of ITers and NITers. However the role of innovations in higher-order lags in inflation on inflation has fallen on average among ITers but increased among non-ITers—for both sample definitions corresponding to Figures 4(a) and 4(b). This is suggestive of the role of IT in partly substituting forward-looking inflation expectations (influenced by the official inflation target) for the backward-looking roots of the inflation process.

We do not find much difference between ITers and non-ITers regarding the cross-effects of inflation shocks on output gap variances. In both country groups the effects are small and tend to fall during the 1990s. Regarding the opposite cross-effect—from inflation innovations to output gap variances—more significant differences emerge between both country groups. Among ITers a large reduction in the role of inflation innovations on output variance took place in the 1990s, towards levels closer to those of NITers,

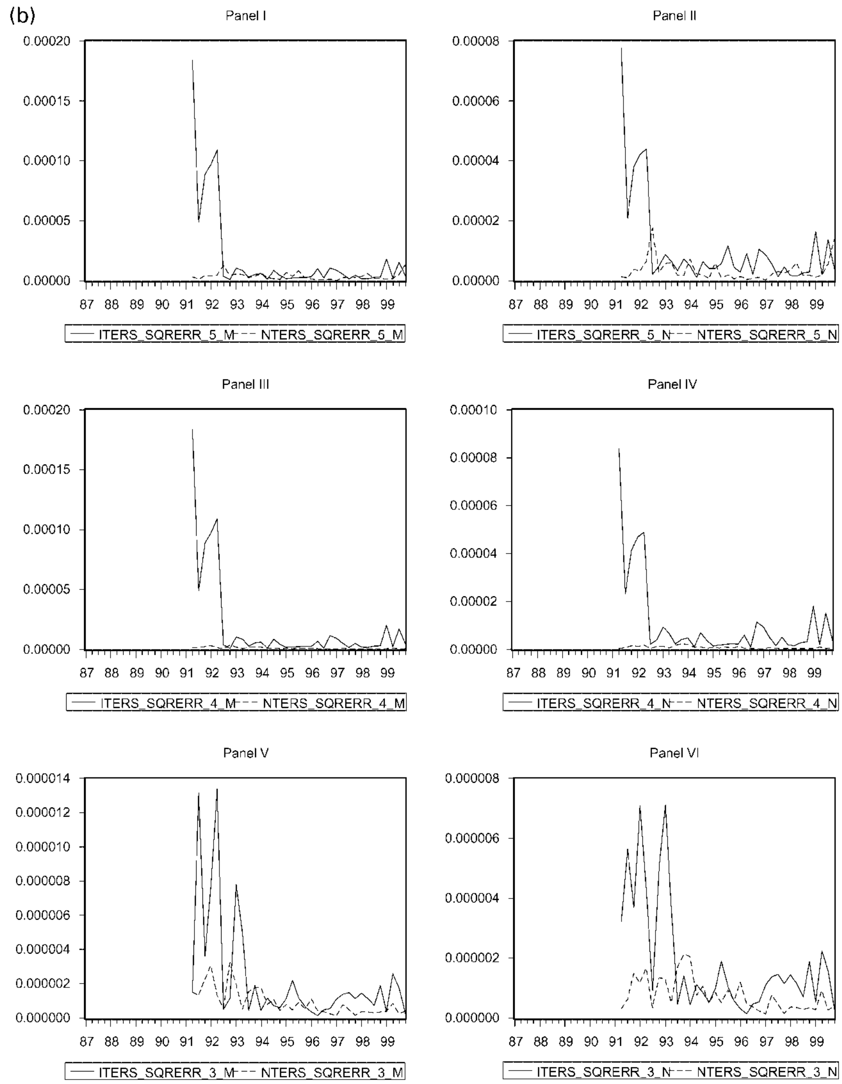

Figure 3. (Continued)

who also observed some reduction in the role of inflation innovations. Hence IT may have contributed to anchor inflation expectations, helping in isolating the output gap to inflation innovations.

A third and final difference among country groups is observed regarding lagged output gap innovations on the current output gap variance. On average, output persistence—at every lag—has increased by a sizable amount among ITers throughout the 1990s, toward levels comparable to those of non-ITers, whose output persistence did not change much during the decade.

The effect of innovations in the nominal exchange rate on inflation variance can be interpreted as the reduced-form passthrough from devaluation to inflation. No major differences were observed at the aggregate level of country samples—nor over time—regarding the latter innovations.[15]

No major differences between ITers and non-ITers are observed regarding the effects of innovations in or on other variables, with the exception of the effects of innovations on interest rates, that are discussed in Section 6.

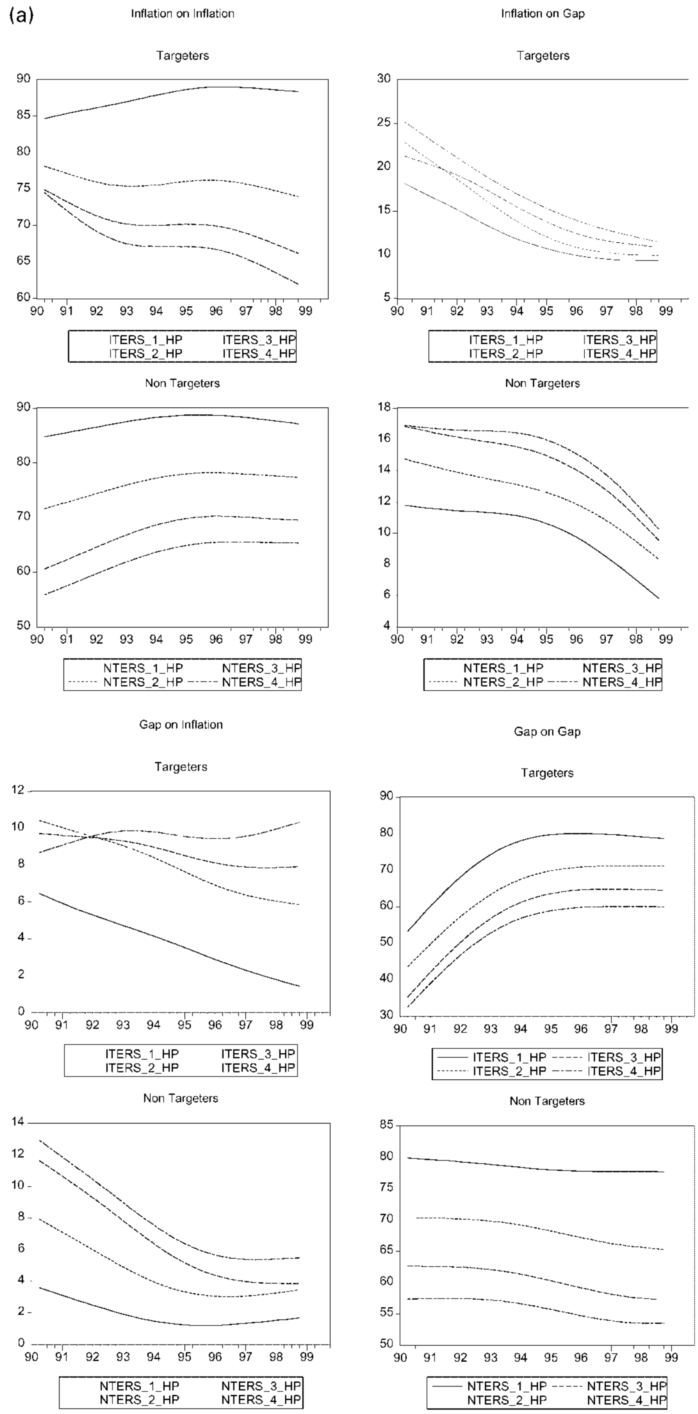

Figure 4. (a) Dynamic variance decomposition for inflation and output gaps, full country sample (obtained from out-of-sample forecasts of a rolling VAR): 1990–98, quarterly data. (b) Dynamic variance decomposition for inflation and output gaps, industrial-country sample (obtained from out-of-sample forecasts of a rolling VAR): 1990–98, quarterly data.

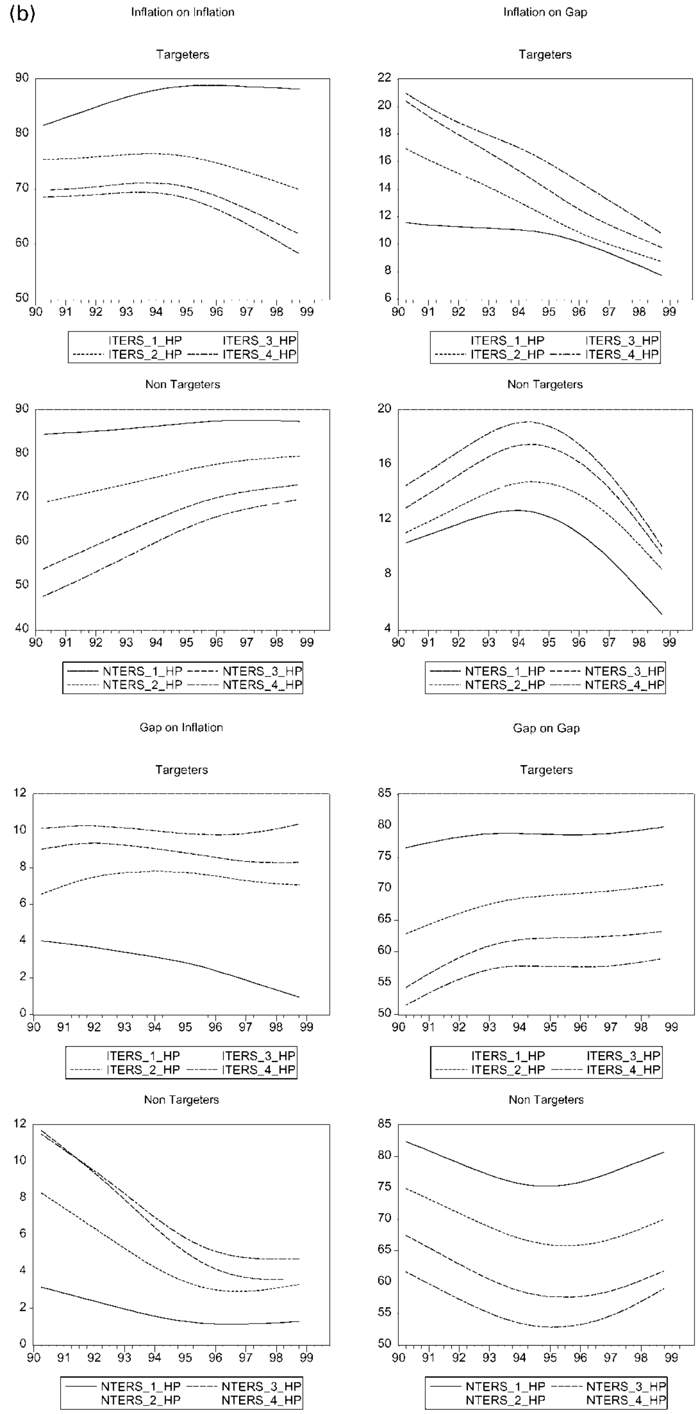

Figure 4. (Continued)

5. DOES IT CHANGE CENTRAL BANK AVERSION TOWARDS INFLATION?

Cecchetti and Ehrmann (2000), henceforth CE, have developed a useful and simple model to derive and measure the aversion of central bankers to inflation variability relative to their aversion to output variability. By maximizing a standard quadratic loss function subject to linear aggregate supply and aggregate demand equations, they derive the following equation that relates the relative aversion to inflation variability (α) to the slope of the aggregate supply curve (γ) and the variance of inflation (σ_π^2) and output (σ_y^2):

$$\frac{\sigma_y^2}{\sigma_\pi^2} = \left[\frac{\alpha}{\gamma(1-\alpha)}\right]^2 \tag{1}$$

Using Equation (1) country data for inflation and output variances and estimating aggregate supply slopes from impulse response functions that derive the output effects of supply shocks, CE calculate the inflation-aversion coefficient (α). From their country-by-country results, based on quarterly data for the 1980s and 1990s for nine ITers and 14 NITers, CE conclude that, on average, the inflation aversion of ITers is not higher than in the control group of NITers. However, by using rolling regressions for shorter sub-samples, they also find that inflation aversion has increased significantly in most ITers shortly before, during, or after adoption of IT.

Next we redo CE's calculation for our samples of ITers and NITers, departing in four important ways from their empirical procedures. First, our sample differs from theirs in country composition and time coverage. Regarding the latter, our quarterly sample extends from 1980 through 1999, which is longer than theirs. Second, CE define the deviation of inflation (and the corresponding variance) with regard to a constant 2% annual inflation rate, while we define it as the deviation from an estimated HP trend (as discussed in Section 3) (for non-ITers) or the deviation from inflation target levels (for ITers). This has important consequences for the time-varying measures of inflation variance, as discussed below. Third, we re-estimate output supply slopes from impulse response functions based on the country VARs run in Section 3 and add alternative estimates based on simple Phillips-curve estimations. Finally, we re-estimate inflation and output variances from our country samples.

Our results of cumulative impulse responses of output to interest rate shocks at quarterly leads, ranging from one to 13 quarters, show a wide range of period and country responses, from large positive to large negative supply slopes. The time averages over the 13 lead responses for each country (except the 5% tails of the cross-country time-series distribution) vary between −7.2 (France) and 10.7 (the Netherlands). We rescale linearly the latter ordering to obtain a ranking of output slope coefficients in the range spanned from 0.1 to 6.0.

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

$$ygap_t = \delta_0 + \delta_1(\pi_t - \pi_{t-1}) \tag{2}$$

or

$$ygap_t = \delta_0 + \delta_1(\pi_t - E_{t-1}\pi_t) \tag{2'}$$

where the last period's expectation of current inflation is obtained from out-of-sample inflation projections from the VARs used in Section 3.

Two measures for the output gap (*ygap*) were applied by using the deviations from HP trend levels of GDP and industrial output, as defined in Section 3. The different combinations of equations and output measures were estimated by OLS and TSLS (using the interest rate as the instrument for the inflation deviation, to be consistent with the VAR impulse response estimates). The sample period extends from 1980 to 1999, with quarterly data frequencies. The eight slope coefficients for the corresponding combinations of equations, output measures and estimation techniques again vary widely by estimated equation and country. Averages for each country across equations (outliers were defined as the observations of the 5% tails) again were linearly rescaled, obtaining slope coefficients in the 0.10–6.0 range.

The first four columns in Table 8 report supply slope coefficients according to four available measures: the original average cross-country CE measure (2.83), the original country CE measure for those countries included by CE or 2.83 for the excluded countries, our first country measure from VAR impulse responses, and our second country measure from Phillips curves. There is much output slope variation across countries. Across our three country groups, the variation is smaller. However it is interesting to note that gammas appear to be on average consistently (i.e., in columns 2 to 4) higher in ITers than in potential PITers and NITers.

Finally we report in columns 5–8 of Table 8 country inflation aversion coefficients, based on the gammas shown in the corresponding columns 1–4 and country output and inflation variances, by applying equation (5) from CE. Our estimates for alpha are much higher on average than CE's figures, reflecting the fact that our inflation variance is much lower, as discussed above. Across different measures and countries, the average alpha is close to 0.91. There are no difference in alphas between ITers, PITers, and NITers—confirming the earlier CE result.

Next we investigate if the relative aversion to inflation has changed over the 1990s. As CE, we focus on time-varying country estimates of inflation aversion coefficients from rolling 5-year windows. In order to minimize contamination from mismeasurement of output supply coefficient, here we use a common gamma for all countries (2.83 obtained directly from CE). We also focus our discussion on the time pattern of alphas starting about 1990 (hence starting with 5-year windows before 1991) as much noise characterized policies and outcomes until the mid-1980s.

In many countries—across various groups—inflation aversion rose during the 1990s. Among ITers, revealed inflation aversion rose significantly in Finland, Sweden, Chile, and Israel. Also among many NITers inflation aversion increased significantly in the 1990s, as occurred in the the USA, Denmark, France, Germany, the Netherlands, Norway, and Switzerland. Among PITers such a trend is not observed—moreover, alphas declined in Brazil and Mexico during the 1990s. Many of these country results differ significantly from those reported by CE.

We report aggregate dynamic alphas for four country groups and our four alternative estimates for output supply coefficient gamma, on 5-year estimation windows and our inflation variances. The country group results in Figure 5 are quite robust across different gamma estimates (i.e. different panels). They show that for the sub-group of industrial-country ITers the average alpha does not exhibit any time trend during the 1990s although there are cyclical swings. However, inflation aversion shows an upward trend in the two transition ITers—Chile and Israel—since 1990. While in the mid-1990s there is a temporary decline in alpha—largely reflecting a strong temporary decline in Israel—the average alpha is 4 percentage points higher in the late 1990s than around 1990.

Another country group that exhibits a significant trend rise in inflation aversion during the 1990s is the NITers, also by a magnitude close to 4 percentage points. The only group that shows a trend decline in their inflation aversion is the PITers, by an average total reduction of some 2 percentage points.

Hence regarding time trends of aversion coefficients, our results are strikingly different from CE's. Only transition ITers (Chile and Israel) show a trend increase in their alphas during the 1990s. In this behaviour they are similar to industrial-country NITers, not to other ITers.

6. DOES IT CHANGE CENTRAL BANK BEHAVIOUR?

In this section we analyse if ITers differ from non-ITers regarding the behaviour of central banks in setting their policy instrument—the interest rate. We approach this question from two different angles. First we report the results of inflation and output innovations on the variance of interest rates, based on dynamic variance decompositions performed on the rolling VARs estimated in Section 3 and already applied to other variance decompositions in Section 4. Then we report econometric results for simple Taylor policy rules to infer about the weights of inflation and output gaps in the evolution of short-term interest rates.

In Figure 6 we present the dynamic variance decomposition for the gap and inflation pressure on the interest rate. The two top panels are for the whole samples of ITers and NITers and the two bottom panels

Table 8. Estimates of Central Bank inflation aversion: robustness exercise

	Gammas				Alphas			
	Average of Cecchetti and Ehrmann	Cecchetti and Ehrmann or Average	Ranking of aggregate supplies	Ranking of impulse responses	Average of Cecchetti and Ehrmann	Cecchetti and Ehrmann or Average	Ranking of aggregate supplies	Ranking of impulse responses
Inflation targeters	2.83	3.39	3.83	2.63	0.92	0.89	0.94	0.89
Australia	2.83	4.65	3.71	2.80	0.88	0.92	0.90	0.88
Canada	2.83	1.80	2.71	2.72	0.93	0.90	0.93	0.93
Chile	2.83	0.84	6.00	2.73	0.95	0.85	0.98	0.95
Finland	2.83	3.76	3.14	1.68	0.94	0.95	0.94	0.90
Israel	2.83	1.42	4.07	3.23	0.88	0.79	0.92	0.90
New Zealand	2.83	0.67	3.25	0.60	0.92	0.74	0.93	0.72
Spain	2.83	1.22	4.59	5.65	0.96	0.90	0.97	0.98
Sweden	2.83	2.35	3.33	1.91	0.94	0.93	0.95	0.92
UK	2.83	13.76	3.70	2.34	0.89	0.97	0.91	0.87
Potential targeters	2.83	2.83	2.36	2.36	0.92*	0.92*	0.91*	0.90*
Brazil	2.83	2.83	0.10	2.46	0.93	0.93	0.35	0.92
Czech Republic**	2.83	2.83	3.00	3.00	0.84	0.84	0.84	0.84
Colombia	2.83	2.83	3.43	1.19	0.97	0.97	0.98	0.94
Korea	2.83	2.83	3.40	1.75	0.92	0.92	0.93	0.87
Mexico	2.83	2.83	1.90	2.70	0.91	0.91	0.88	0.91
South Africa	2.83	2.83	2.34	3.07	0.97	0.97	0.97	0.98
Non-targeters	2.83	3.20	2.52	2.54	0.93	0.91	0.92	0.88
Denmark	2.83	0.70	3.29	2.32	0.94	0.80	0.95	0.93
Francia	2.83	6.15	2.59	0.10	0.94	0.97	0.93	0.41
Germany	2.83	5.72	2.57	1.61	0.91	0.95	0.90	0.85
Indonesia	2.83	2.83	1.04	2.61	0.94	0.94	0.86	0.94
Italy	2.83	4.89	2.25	2.90	0.94	0.97	0.93	0.95
Japan	2.83	1.09	3.16	2.38	0.94	0.87	0.95	0.93
Netherland	2.83	2.03	2.96	6.00	0.91	0.88	0.91	0.95
Norway	2.83	2.83	3.10	2.73	0.93	0.93	0.94	0.93
Portugal	2.83	2.83	2.19	2.89	0.95	0.95	0.94	0.95
Switzerland	2.83	5.08	1.42	2.52	0.92	0.95	0.86	0.91
USA	2.83	1.10	3.12	1.90	0.92	0.83	0.93	0.89

[a]Without Brazil in average.
[b]We assume the Czech Republic's gamma to be average in all four rankings, alphas based on data from 1993 onwards.

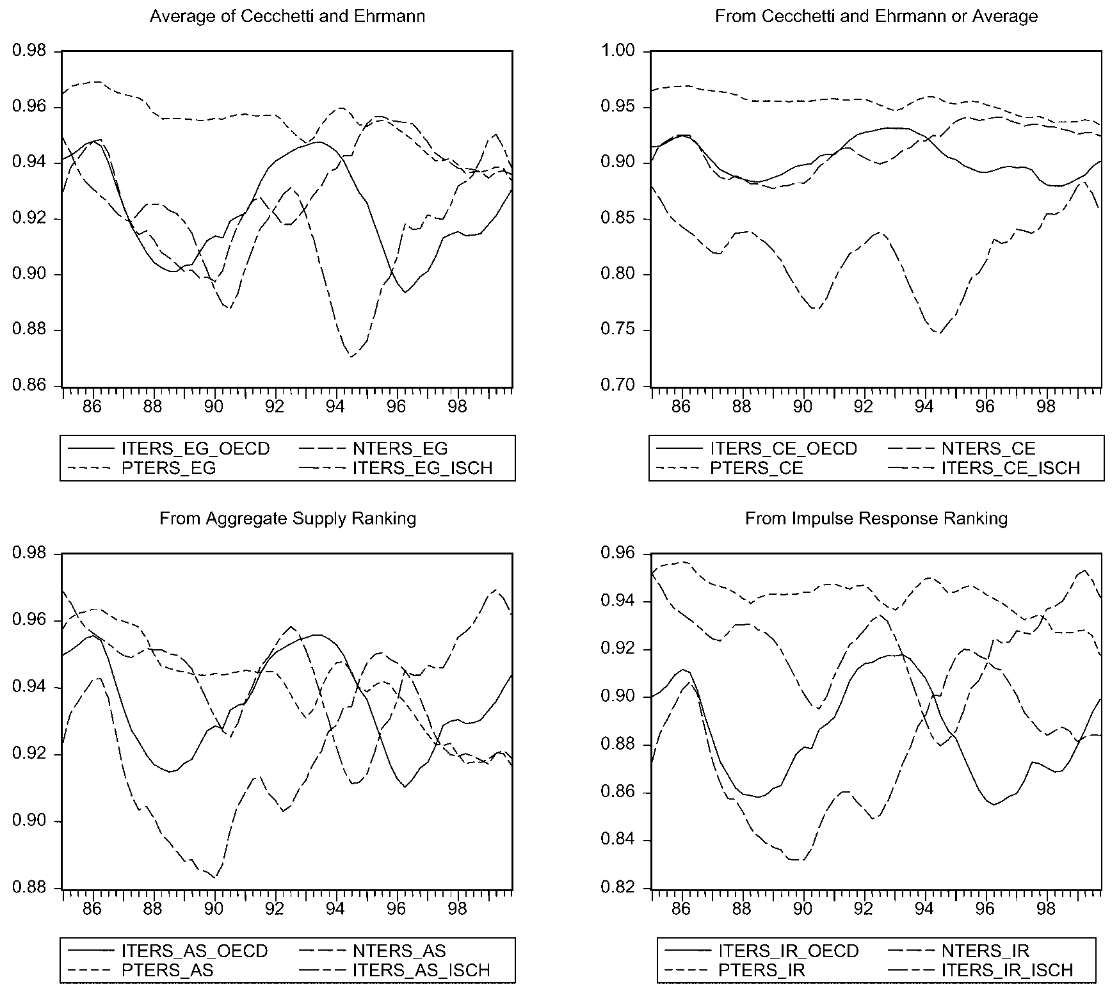

Figure 5. Dynamic inflation aversion, coefficients of OECD inflation targeters (ITERS_OECD), Israel and Chile (ITERS_ISCH), potential targeters (PITERS) and non-targeters (NTERS).

are for the industrial-country sub-samples of ITers and NITers. The most interesting result is that ITers have been able to lower the reaction of the interest rate to innovations in both inflation and the gap during the 1990s. This result is robust to inclusion or exclusion of non-industrial countries in the groups of ITers and NITers. It suggests that ITers have gradually reaped a credibility gain that allows them to achieve their inflation targets with gradually smaller changes in interest rates. Among NITers, however, the impact of inflation innovations on interest rates has not declined in the 1990s while there is some decline—at the first and second lags—of the effect of output gap innovations on interest rates among NITers.

Next we estimate a simple Taylor rule consistent with a reduced-form partial-adjustment equation for the reaction of the central bank to inflation and output gaps.[16] This equation is consistent with a central bank that determines its policy rate (r) as a weighted average of the one-period lagged rate and the optimal rate, and the latter is a function of both contemporaneous gaps, giving rise to the following reduced-form equation:

$$r_t = \delta_0 + \delta_1 r_{t-1} + \delta_2 \pi gap + \delta_3 ygap \tag{3}$$

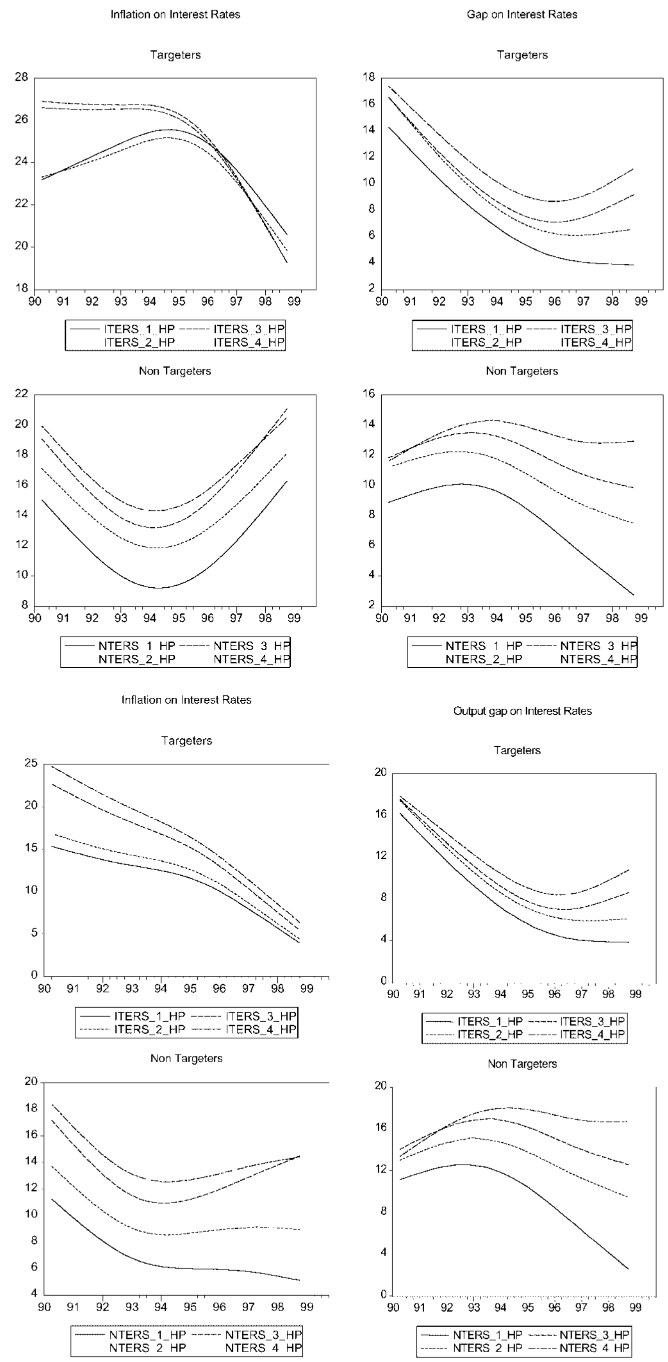

Figure 6. Dynamic variance decomposition for interest rates, ITers and non-ITers (obtained from out-of-sample forecasts of a rolling VAR): 1990–98, quarterly data.

where πgap (the inflation gap) is the difference between actual and target inflation for ITers and between actual and trend inflation for non-ITers, and $ygap$ (the output gap) is the difference between actual and trend industrial output.

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

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

The long-term inflation gap coefficient is positive and significantly different from zero in three ITers (UK, Australia, and Israel), four NITers (the USA, the Netherlands, Japan, and Portugal), and three PITers (Brazil, Colombia, and Korea). Country output gap coefficients are positive in most countries, and positive and significantly different from zero in 10 countries.

Simple averaging across our three country groups allows us to obtain the group coefficients identified at the bottom of Table 9. Among the three groups, ITers exhibit the largest inflation gap coefficient relative to the output gap coefficient although both coefficients are not significantly different from zero. NITers show gap coefficients that are small and similar in size, although only their output gap coefficient is significantly different from zero.

Next we perform rolling estimations of country Taylor rules for 10-year windows. The regressions are performed for the same samples of total ITers and NITers for which the variance decompositions for interest rates were reported in Figure 6. The corresponding results in Figures 7(a) and 7(b) are very consistent with those reported in Figure 5. Both the inflation and output gap coefficients have declined consistently among ITers—and this is observed both including transition ITers Chile and Israel (in Figure 7(a)) and excluding them (in Figure 7(b)). Such a reduction is not observed among NITers, where both inflation and output gap coefficients do not exhibit any trend in the 1990s. Hence these results confirm that ITers have gradually established credibility, requiring smaller changes in interest rates in response to inflation or output shocks in the late 1990s than when they started IT in the early 1990s.

7. CONCLUSIONS

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

ITers have been very successful in meeting their targets. Output sacrifice ratios measured by industrial production were lower after IT adoption among ITers than among potential targeters and non-targeters during the 1990s. Volatility of industrial output fell in most ITers after IT adoption to levels similar to those among non-targeters.

ITers have consistently reduced inflation-forecast errors (based on country VAR models) after IT adoption, toward the low levels prevalent in non-targeting industrial countries.

Variance decomposition results from VARs show that the influence of price and output shocks on the behaviour of inflation and output gaps has changed much more strongly among ITers than in non-targeting industrial countries in the course of the 1990s. Inflation persistence declined strongly among ITers during the 1990s. This suggests that IT has played a role in strengthening the effect of forward-looking expectations on inflation, hence weakening the weight of past inflation inertia. The influence of inflation shocks on output has declined while output persistence has increased significantly during the 1990s. The

Table 9 Estimation results of simple Taylor rules for inflation targeters and non-targeters (1990.1–1999.4)

	Lagged interest rates	Inflation gap (1)	Activity gap (2)	Adjusted R-squared
USA	0.78**	0.21**	0.22**	0.97
	0.04	0.08	0.03	
UK	0.87**	0.27**	0.04	0.97
	0.04	0.11	0.08	
Denmark	0.94**	0.06	0.12	0.81
	0.09	0.95	0.13	
France	0.97**	−0.12	0.07**	0.98
	0.02	0.11	0.02	
Germany	0.98**	0.04	0.10**	0.99
	0.01	0.03	0.01	
Italy	0.94**	0.27	0.02	0.85
	0.08	0.32	0.09	
Netherlands	0.97**	0.34*	0.08*	0.97
	0.03	0.21	0.05	
Norway	0.82**	−0.51	0.09	0.67
	0.10	0.69	0.14	
Sweden	0.54**	0.26	0.04	0.26
	0.16	0.38	0.24	
Switzerland	0.95**	0.12	0.07*	0.96
	0.04	0.12	0.04	
Canada	0.97**	−0.14	0.17**	0.92
	0.05	0.12	0.06	
Japan	0.98**	0.09*	0.02	0.99
	0.02	0.06	0.01	
Finland	0.97**	0.17	0.01	0.98
	0.04	0.11	0.03	
Portugal	0.98**	0.36**	0.02	0.98
	0.03	0.14	0.06	
Spain	0.99**	0.27	0.05	0.97
	0.03	0.25	0.05	
Australia	0.79**	0.17**	0.09**	0.98
	0.03	0.06	0.04	
New Zealand	0.92**	−0.07	0.17**	0.86
	0.08	0.17	0.08	
South Africa	0.80**	0.12	0.13*	0.81
	0.08	0.14	0.08	
Brazil	−0.07	3.69**	73.59	0.12
	0.21	1.81	315.53	
Chile	0.65**	0.68	0.00	0.40
	0.13	1.05	0.41	
Colombia	0.85**	0.62**	0.26*	0.76
	0.09	0.19	0.15	
Mexico	0.59**	−0.07	−0.94	0.57
	0.14	0.16	0.51	
Israel	0.71**	0.23**	−0.19	0.80
	0.08	0.08	0.13	
Indonesia	1.02**	−0.22	0.17	0.81
	0.11	0.15	0.15	
Korea	0.68**	0.56**	0.09	0.60
	0.15	0.28	0.09	
Inflation targeters	0.82**	0.21	0.04	
	0.03	0.13	0.06	
Recent targeters (less Brazil)	0.73**	0.31	−0.11	
	0.06	0.37	0.14	
Non-targeters	0.94**	0.06	0.09**	
	0.02	0.12	0.03	

(1) As deviations from an HP1600 trend.
(2) Anualized deviations from inflation target or an HP1600 trend.
Note: standard errors are *noted* in parentheses. Coefficients with one (two) asterisks denote a significance level of 10% (5%).

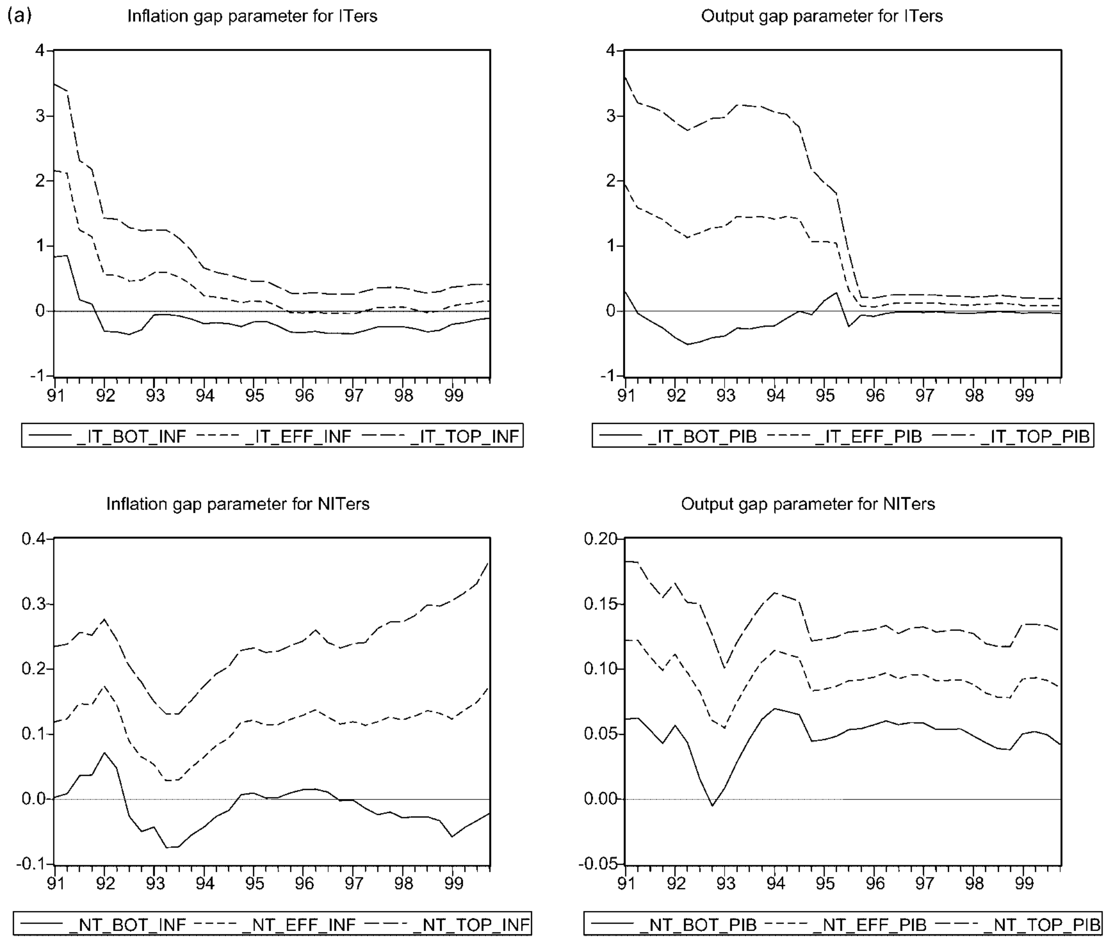

Figure 7. (a) Rolling Taylor rule coefficients for industrial ITers plus Chile and Israel and industrial NITers (Taylor rule estimated with contemporary inflation and activity as independent variables). (b) Rolling Taylor rule coefficients for industrial ITers and industrial NITers (Taylor rule estimated with contemporary inflation and activity as independent variables).

influence of price and output shocks on inflation and output gaps tended to converge among ITers in the late 1990s to the patterns observed among non-targeting industrial countries.

Regarding exchange-rate innovations on inflation—evidence of reduced-form devaluation-inflation passthroughs—no differences were identified between stationary (industrial-country) ITers and non-targeting industrial countries. However both transition ITers (Chile and Israel) show a significant decline in the share of exchange-rate innovations in inflation variance during the 1990s. This suggests that the passthrough has fallen as both countries have actually converged (Chile in 1999) or are converging (Israel) towards a floating exchange regime.

Cecchetti and Ehrmann (CE) found that the aversion of central bankers towards inflation did not differ, on average, between ITers and NITers. However, they found that inflation aversion increased significantly in most ITers when they adopted ITs (i.e. during the 1990s) as opposed to non-targeters. We extended CE's estimates and inflation-aversion measures in various ways and confirmed their first result: inflation aversion is, on average, not different among ITers in comparison to NITers. However, in opposition to CE's second result, we do not find evidence that industrial-country (stationary) ITers showed increasing inflation aversion through the 1990s. In contrast, inflation aversion increased in the emerging-country (and transition) ITers: Israel and Chile. Also in opposition to CE, we find a trend increase in inflation

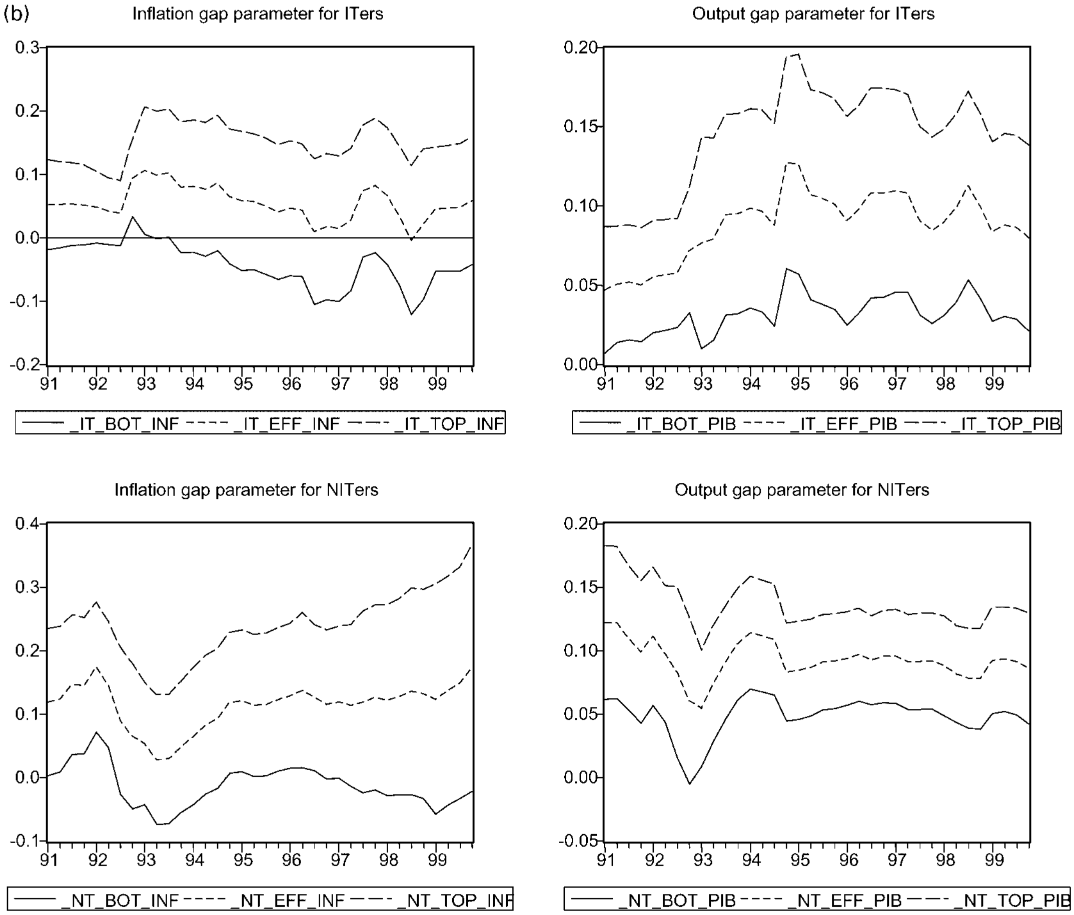

Figure 7. (Continued)

aversion among industrial-country NITers. Among potential ITers (PITers), inflation aversion fell during the 1990s.

Does IT change central bankers' behaviour in setting interest rates? First we performed variance decomposition exercises from country VARs to test for changes in the response of interest rates to inflation and output innovations. In fact, the reaction of interest rates to both inflation and output shocks has declined significantly among ITers throughout the 1990s. Among industrial-country NITers, however, these reductions were either nil or much weaker in the 1990s. Next, we estimated Phillips curves that confirmed the latter result: the coefficients of inflation and output gaps have monotonically declined in both emerging and industrial ITers during the 1990s—as opposed to unchanged parameters among NITers. This result suggests that ITers have gradually reaped a credibility gain, allowing them to achieve their ITs with smaller changes in interest rates in the late 1990s than the changes that were necessary to adopt in the early 1990s.

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DATA APPENDIX

Inflation targeting periods

Consider countries as inflation targeters in the following periods: United Kingdom from the fourth quarter of 1992 onwards, Sweden from the first quarter of 1993 onwards, Canada from the first quarter of 1991 onwards, Finland from the first quarter of 1993 to the present, Spain form the third quarter of 1996 to the fourth quarter of 1998, Australia from the fourth quarter of 1994 onwards, New Zealand from the second quarter of 1990 onwards, Chile from the fourth quarter of 1990 onwards and Israel from the first quarter of 1991 onwards.

Industrial production

For all countries, except for the following, the Seasonally Adjusted Industrial Production Index, code 66.. czf of the IFS catalogue, for Switzerland, the Seasonally Adjusted Industrial Production Index (90 = 100), code 66.. izf of the IFS catalogue, for Turkey, the Industrial Production Index, code 66.. zf of the IFS catalogue, for New Zealand, the Seasonally Adjusted Manufacturing Production Index, code 66ey.czf of the IFS catalogue, for Chile, Colombia and Mexico, the Manufacturing Production Index, code 66ey.czf of the IFS catalogue.

Money—For all countries, except for the following, Money, code 34..zf of the IFS catalogue + Quasi-Money, code 35..zf of the IFS catalogue, Germany, Italy, Finland and Spain, Currency in Circulation + Demand Deposits, code 34a.nzf + 34b.nzf of the IFS catalogue.

Inflation—For all counties, Consumer Prices, code 60..zf of the IFS catalogue.

Interest rate—1 For Norway, Denmark, Sweden and Spain, the Call Money rate, code 60 b..zf of the IFS catalogue, for Switzerland, Italy, Korea and Japan, the Money Market rate, code 60 b..zf and 60 p..zf of the IFS catalogue, for the USA, the Federal Funds rate, code 60 b..zf of the IFS catalogue, for the United Kingdom, the Overnight Interbank rate, code 60 b..zf of the IFS catalogue, for Canada, the Overnight Money Market rate, code 60 b..zf of the IFS catalogue, for Finland, the Average Bank Lending rate, code 60 p..zf of the IFS catalogue, for Turkey, the Interbank Money Market rate, code 60 b..zf of the IFS catalogue, for Austria, the New Issue rate -3 Months T-Bills, code 60 c..zf of the IFS catalogue, for New Zealand, Comm. Bill Rate (90 Day Max), code 60 b..zf of the IFS catalogue, for Chile, the Monthly Average rate of 90-D Deposit Certificates, source BRC, for Mexico, the Treasury Bill rate, code 60 b..zf of the IFS catalogue, for Israel, the Overall Cost of Unindexed Credit, code 60 p..zf of the IFS catalogue, for Colombia, the Lending rate, code 60 b..zf of the IFS catalogue.

Nominal exchange rate—For all countries, except for the following, the Market rate, code ..rf..zf of the IFS catalogue, Norway, Sweden, Switzerland and Finland, the Official rate, code ..rf..zf of the IFS catalogue, Chile and Mexico, the Principal rate, code ..rf..zf of the IIFS catalogue.

For any variable x, we construct $\log(x) - \log(hpx)$. In this measure of deviations from trend we compare each moment's observation with the trend, ignoring the position of the variable with respect to the trend in the previous period. With this variable we are measuring the position of the variable with respect to the trend and not the change of the variable from period to period.

NOTES

1. See in particular Leiderman and Svensson (1995), Mishkin and Posen (1997), Bernanke *et al*. (1999), Kuttner and Posen (1999), Haldane (1999), Mishkin (2000), Mishkin and Savatano (2000), Schachter *et al*. (Practical issues in the adoption of inflation targeting by emergent market countries. Unpublished manuscript, IMF, 2000).
2. The Czech Republic and Poland were not included due to lack of information.
3. Switzerland adopted inflation targeting in December 2000.
4. Starting dates are defined by the first month of the first period for which inflation targets have been announced previously. For example, the starting date for Chile is January 1991 (the first month of the calendar year 1991, for which the first inflation target

was announced in September 1990). The initial inflation level is defined as the year-on-year CPI inflation rate of the last quarter before the first month of inflation targeting (for instance, 1990.4 in the case of Chile).

5. Inflation attained one quarter before adopting IT.
6. Sacrifice ratios are computed as ratios of the sum of deviations of potential from actual output divided by the reduction in CPI inflation. They were based on annual frequency for GDP-based measures and quarterly data for industrial ouput-based measures. Average sacrifice ratios based on industrial output are calculated with and without two large outliers (Chile and Spain).
7. We use industrial production to construct a measure of the production gap due to availability of quarterly data for some of our emerging market economies.
8. In the following sections we assume that short-term interest rates are, over quarterly averages, closely aligned with the policy interest rate of the central bank.
9. The dynamic properties and hence the importance of characteristics such as the ordering of the endogenous variables become relevant in the following sections.
10. The Kullback–Liebler distance is a measure of the distance from the maximum likelihood fit of the model, and is calculated as the sum (the integral) of the deviations of the maximum likelihood function evaluated at the estimated parameters from the true fit. This measure is usually used to evaluate the fit of a time-series model and is usually approximated by the Akaike Information Criteria (AIC). It can be shown that the AIC is inconsistent in the sense that it picks larger than optimal lags. There are many ways of correcting this, usually consisting in penalizing the number of lags in the statistic. We present two of these: the Schwartz (SIC) and the Hannan–Quinn information criteria (HQIC).
11. A variance decomposition is a dynamic simulation of the estimated system where a shock to an endogenous variable is separated into the orthogonal component shocks to the endogenous variables of the VAR. As usual the orthogonalized errors are constructed decomposing the estimated errors according to a Cholesky decomposition of the variance–covariance matrix.
12. Since in Section 3.1 we did not find major differences between the results from rolling VARs and recursive VARs, here we perform the exercise on rolling VARs only, in order to maximize the observed changes in economic structure.
13. The USA, the United Kingdom, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Portugal, Spain, Australia, New Zealand, South Africa, Brazil, Chile, Colombia, Mexico, Israel, Indonesia, and Korea.
14. Same countries as in preceding note, except African, Latin American, and Asian countries.
15. However, some interesting results were obtained at the country level. For the two transition ITers that have converged during the 1990s to steady-state inflation Chile and Israel show a decline in the share of exchange-rate innovations in inflation variance during the 1990s. This result supports the notion that the devaluation-inflation passthrough has declined in both countries during the 1990s, as a result of recent (Chile) or ongoing (Israel) convergence toward a flexible exchange-rate regime and achievement of stationary inflation in both countries
16. On the robustness of simple Taylor rules see Taylor (2000).

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