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Inflation Targeting Twenty Years on:
Where, When, Why, With what Effects, What lies ahead? *

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Revised, October 2009

Abstract

This paper looks back at 20 years of inflation targeting (IT) in the world, reviewing previous findings and reporting new cross-country and panel-data evidence on the determinants or IT regime choice and the results of IT adoption. After describing the where and when of IT adoption, the paper assesses the determinants of why countries choose this monetary regime against alternative candidates. Which have been the main results under IT? Next the paper focuses on several dimensions of monetary policy performance under IT. One is target achievement; beyond measuring cross-country differences in target deviations, the paper assesses empirically what lies behind those deviations. Two, it reviews monetary policy efficiency more broadly, comparing output and inflation volatility under IT to volatility observed in non-IT experiences. Three, it surveys descriptive evidence on monetary policy transparency attained under IT in comparison to other monetary regimes. A discussion of the very important challenges posed by the recent boom-and-bust cycle to IT close the paper.

Key Words: Inflation targeting, inflation, monetary regimes

JEL Classification: E31, E52, C58

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Carl Walsh (2009a):

"The ability to deal with demand shocks and financial crises can be enhanced by a commitment to an explicit (inflation) target"

Joseph Stiglitz (2008):

"Today, inflation targeting is been put to the test – and it will almost certainly fail"

Introduction

Two decades have passed since the Reserve Bank of New Zealand pioneered modern monetary policy practice by adopting inflation targeting (IT). Since then, IT has gained followers and reputation, becoming the monetary regime of choice among many central bankers and academics. This preference has been revealed by the fact that no central bank endowed with monetary sovereignty that has adopted IT since 1989 has abandoned IT – until now, at least.[1] While at the time of this writing, in the midst of the worst financial crisis and global recession in a lifetime, it seems a bit adventurous to provide a firm forecast on IT's future prospects, my bet is that Walsh will be proven right in its quote and Stiglitz wrong.

Widespread adoption of IT as the frontier monetary regime around the world poses some questions about the economic and institutional factors that lead countries to adopt and sustain IT, and about the potential policy and performance benefits of IT. On what drives countries to implement IT, earlier studies point toward the role of initial institutional and economic conditions satisfied when adopting and maintaining IT adoption (e.g., Mishkin and Schmidt-Hebbel, 2007). In contrast, Batini and Laxon (2007) show that initial conditions do not matter for adopting IT – most countries build up gradually, after starting IT, better macroeconomic conditions and institutional features of full-fledged IT.

[1] Three European countries (Finland, Spain, and the Slovak Republic) that had adopted IT in the past have relinquished monetary sovereignty subsequently by adopting the euro and hence abandoning IT. They will be followed my more currently IT and non-IT European countries in the future.

The literature on the benefits of IT is older and deeper, spanning a decade of empirical research on its potential effects on inflation levels, output and inflation stability, inflation expectations, exchange-rate to inflation pass-through, monetary policy efficiency, and anchoring of inflation expectations, among other policy performance indicators. Such research includes, *inter alia*, country and cross-country empirical work reported by Corbo et al. (2002); Mishkin and Savastano, 2000; Mishkin and Schmidt-Hebbel, 2007; Schmidt-Hebbel and Werner, 2002; Carare and Stone, 2003; Vega and Winkelried, 2005; Mishkin and Schmidt-Hebbel, 2007; Gürkaynak et al., 2007; De Carvalho and Minella, 2009; and other contributions published in the volumes edited by Bernanke *et. al*., 1999; Bernanke and Woodford (2005); Mishkin and Schmidt-Hebbel (2008); and Schmidt-Hebbel and Walsh (2009). An outlier is the finding by Ball and Sheridan (2005) that IT does not improve macroeconomic performance in industrial countries, compared to other industrial countries that do not target inflation, at least explicitly.

IT also enhances the transparency of monetary policy, largely because it relies heavily on inflation forecasts (hence Svensson (1997)'s labeling of IT as "inflation-forecast targeting) and private-sector inflation expectations. This feature enhances the efforts of IT central banks in strengthening their forms of communication with the markets and the general public, upgrading and reinforcing their transparency and governance (Eijffinger and Geraats, 2006, and Geraats, 2008).

Yet against IT's generally remarkable record, the world economy's 2002-2010 boom-bust cycle, triggered and deepened by a massive financial crisis in industrial economies, has put into question the analytical foundation, forecasting, and policy making of modern monetary policy making – with or without explicit IT. For example, Buiter's (2009) scathing indictment of modern macroeconomics, finance, and monetary policy started a timely debate on the limitations and failures of the analytical foundations and policy practice in the latter fields, finding in Lucas (2009) a strong defender of the "dismal science". This debate and its implications for theory and policy are just starting, and will also certainly affect our future understanding of best monetary policy practice in general and under IT in particular.

This paper is laid out as follows. I start in section 1 by describing the where and when of IT adoption, focusing on the world sample of currently 28 countries that have IT in place. Next I focus on the why of IT adoption, by assessing empirically the main determinants that lead central banks to choose this monetary regime. In section 3 I review the cross-country performance of IT central banks in attaining their targets, assessing empirically the role of institutional factors that drive those results. Then I present and survey evidence on the role of IT in three areas of monetary policy performance: inflation levels, policy efficiency, and policy transparency. In section 5 I discuss some questions posed to the conduct of monetary policy at large – and under IT in particular – by the still ongoing boom-bust cycle *cum* financial crisis. Brief conclusions close the paper.

1. Where and when? The spreading of IT

The number of IT countries has increased from 1 in 1989-1990 (New Zealand, the "mother of all ITers") to 28 in late 2008 (Fig. 1).[2] Among industrial countries, IT is not particularly popular – only 8 of them have joined the IT club to date, the last two ones in 1999. One reason for this is the continuous erosion of monetary sovereignty in Europe as a result of the gradual growth of the Euro Area. The second is that the Big Three – the Fed, the ECB, and the Bank of Japan – have not adopted IT, at least not of the explicit sort favored by the 28 countries included in this paper.[3]

Among developing and emerging-market economies (denoted EMEs subsequently), IT spread early and quickly, starting with Chile in 1991 and growing to 20 countries spread over four continents in late 2008. Many EMEs adopted initially partial IT, shifting only later, and often quite gradually, to full-fledged IT, with all the bells and whistles of frontier-practice IT, including a floating exchange-rate regime and high levels of policy transparency. Moreover, many EME ITers used IT initially as a price stabilization device,

[2] Hammond (2009) presents a detailed overview of the key features of IT in 26 IT central banks and a discussion of the main issues faced by IT today.

[3] It is debatable if Switzerland should be counted as an IT country. The Swiss National Bank does not define its monetary policy framework as that of an explicit inflation targeter. Yet I have decided to include Switzerland in my world count of ITers due to the close similarity of its monetary policy regime to those of other ITers.

adopting the new regime at initially moderate and even high inflation levels and pre-announcing a sequence of annually declining inflation targets – what is termed converging-target IT. As of late 2008 there are 10 EME ITers that have graduated from target convergence by attaining low-inflation stationary inflation targets, 10 other EMEs are still converging toward stationary targets (Table 1).

Adoption dates and inflation rates during the 12 months before adoption show the contrasting experience of IE ITers (with low initial inflation rates; Fig. 2) and many EME ITers (with moderate to high initial inflation rates; Fig. 3).

2. Why? The determinants of adopting IT and holding on to it

Central banks devote time to evaluate if their country's macroeconomic conditions and their own institutional setup and policy framework are ripe for IT adoption, i.e., if they meet so-called pre-conditions for successful IT adoption and maintaining. Standard initial conditions identified by the earlier literature include central bank operational independence, absence of fiscal and financial dominance, and moderately low inflation (e.g., Mishkin and Savastano 2000, Mishkin and Schmidt-Hebbel 2007). In contrast, Batini and Laxton (2008) show that the absence of some of the latter prerequisites at the time of adoption does not inhibit the start of IT.

Next I report selective results work by Calderón and Schmidt-Hebbel (2008a) on empirical determinants of the likelihood of choosing and having in place IT among alternative monetary regimes. The panel-data specification is the following:

(1) $$y_{i,t} = 1(x_{i,t}'\beta + u_i + e_{i,t} \geq 0)$$

where y is a discrete-choice variable that is set equal to 1 if the argument (the IT choice) is positive and 0 otherwise. The set of possible determinants are grouped in matrix x. The country-specific effect is u, e is a zero-mean disturbance term, and i and t are country and time subscripts, respectively.

Equation (1) is estimated by using discrete-choice panel estimation techniques applied to annual data covering 1975-2005 for 98 IT and non-IT countries.[4] Selective results are reported in Table 2. Inflation affects negatively the likelihood of adopting IT. The fiscal position (measured by the government balance ratio to GDP) and domestic financial development (proxied by the private credit ratio to GDP) raise the probability of having IT in place. The two latter variables suggest that a country is more likely to adopt IT in the absence of fiscal and financial dominance, which conforms to the earlier literature on IT preconditions. Also consistent with previous policy views, we report results that IT is more likely in countries with a floating exchange-rate regime in place.[5] GDP per capita – a proxy of overall institutional development, including, for example, central bank independence – is also a significant determinant. Trade openness, which stands as a proxy for the influence of best monetary policy practice abroad, also contributes to having IT in place. Most latter variables, as reflected in alternative specifications, are significant and robust determinants of the choice of IT.

Unfortunately the latter estimation approach drops the country-specific effects and therefore preclude proper computation of the marginal effects of individual determinants on the likelihood of having IT in place. Leyva (2008) overcomes this limitation by estimating jointly the individual (country-specific) effects and the slope parameters, at the cost of restricting the country sample to 25 ITers, spanning 1989-2005, i.e., including several years before IT adoption for each included country.[6] The estimation results by Leyva (2008), based on a similar specification, are also similar to those reported in Table 2. His estimated marginal effects for the main IT choice determinants are reproduced in Table 3. The largest

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[4] Both fixed and random-effects models are estimated. The fixed-effects approach drops the country-specific effects for assuring consistency in the estimation of slope parameters (in contrast to the individual effects). The random-effects model typically assumes a joint normal distribution between individual effects and the rest of the inflation determinants. The drawback of the former approach is that the estimator is restricted to those individuals whose regime choice changes over time (the so-called movers), while the second is not. This explains the difference in sample size between fixed-effects and random-effects results reported in Table 2.

[5] The exchange-rate regime is measured by a dummy variable that takes a value of 1 for fixed and intermediate exchange-rate regimes.

[6] Although the number of countries is severely restricted, he shows that the bias in the estimation of slope parameters is reasonably small.

marginal effects stem from changes in overall development: raising income levels from, say, Indonesia's to Poland's, raises the likelihood of having IT in place by a massive 66%. Significant improvements in the three other determinants – lower inflation, higher financial development, larger trade openness – have smaller effects on the choice of IT.

3. Inflation Deviations from Targets

Monetary policy success hinges on consistent central bank behavior and strong private-sector credibility. ITers have been aiming at the latter by committing to explicit inflation targets. Have they succeeded in meeting their targets? And what explains their success? I answer these questions in two steps. First, I measure inflation deviations from targets using three alternative measures and I estimate half-lives of inflation shocks, for each and every IT country experience and several country groups. Second, I report empirical estimations of the role played by institutional and macroeconomic performance measures in explaining the panel-data variation in inflation deviations from targets, based on Albagli and Schmidt-Hebbel (2008).

For measuring inflation deviations from targets I use (at most) 1990-2008 quarterly data of year-on-year consumer inflation for the world population or 28 ITers and official data on the corresponding inflation targets announced since the countries' IT starting dates.[7]

Three alternative inflation deviation measures are reported for each country since its corresponding IT starting date in Table 5: the mean absolute error (MAE), the mean squared error (MSE), and the root mean squared error (RMSE). Countries are ordered from smallest (Switzerland) to largest (Ghana) MSE or RMSE. The country ranking by MAE is slightly different from the rankings based on any of the two alternative measures but the value or rank correlation between MAE and any of the two alternatives is very high.

[7] Quarterly inflation rates are taken from the IFS (IMF) database. I use annual inflation targets publicly reported in central bank web pages. For converging ITers that announce annual calendar-year inflation targets, I calculate quarterly targets by linear interpolation, assuming that the fourth-quarter inflation target is the annual target announced for the corresponding year.

Interestingly, persistence of inflation shocks – measured by the half-life of monthly inflation deviations from targets[8] – is largely orthogonal to the size of inflation deviations across countries, as shown by the second column of Table 4. Half-lives of inflation deviations range from lows of 6 to 8 months (Armenia, Mexico, Turkey, Norway; although some of these include very few observations) to highs of 27-29 months (United Kingdom, Philippines).

Figures 4-7 depict quarterly inflation deviations measured as MAE for each country over time, reported separately by regional country groups. Figures 8 and 9 report RMSEs for each country by four main country groups. The average RMSE for EMEs is equal to 3 percentage points (p.p.), more than twice the IC's average RMSE of 1.4 p.p. (Fig. 8). The average RMSE of stationary ITers is 2 p.p., close to half of the converging ITers' RMSE of 3.8 p.p.

In order to describe how inflation deviations have changed over time, I compute rolling estimations of RMSEs, using a window size of 8 quarters (Figure 10). Before 2007 both industrial and emerging economies exhibit downward RMSE trends, during the period that has been labelled as the "Great Moderation" (IMF 2006, Calderón and Schmidt-Hebbel 2008b). This came to an abrupt end during the late phase of the boom, as unprecedented commodity price inflation was passed through consumer prices all over the world – especially in EMEs and even more so in converging-target EMEs. Yet for the full 1992-2008 period, this figure confirms that RMSEs are consistently larger in EMEs than in IEs, and so they are in converging as compared to stationary ITers.

Next I focus on potential determinants of inflation target deviations. I follow Albagli and Schmidt-Hebbel (2008) in specifying the deviation of inflation from target as a function of institutional development, controlling for oil and exchange-rate shocks:

$$(1) \quad AD_{i,t} = \beta_1 abs(OIL_{i,t}) + \beta_2 abs(NER_{i,t}) + \beta_3 IICR_{i,t} + u_i + e_{i,t}$$

[8] Half-lives are computed from a simple AR(1) process for each country's monthly inflation deviation from target, by calculating the impulse response for a unitary (1- percentage- point) shock.

where *AD* is the absolute value of inflation deviation, *abs()* denotes absolute value, *OIL* is the HP-filtered oil price, *NER* is the nominal exchange rate depreciation, and *IICR* is the Institutional Investor's Credit Rating index. The country-specific effect is *u*, *e* is a zero-mean disturbance term, and i and t are country and time subscripts, respectively.

The main hypothesis is that IICR (and a separate measure of central bank independence, CBI) contribute to stronger monetary policy credibility and better-anchored inflation expectations, reducing the size of inflation deviations from targets. Table 5 reports unbalanced panel-data evidence from a world sample of 19 IT countries, based on annual data spanning at most 1990-2003. Controlling for the influence of oil and exchange-rate shocks, IICR is shown as a significant and robust factor in lowering inflation deviations. CBI may also help in reducing inflation deviations from targets but its influence is less robust to changes in specification.

4. Which other Results?

In this section I report other performance results of IT, also drawing from cross-country and panel-data evidence. I focus on three performance measures: long-term inflation levels, monetary policy efficiency, and central bank transparency.

Mishkin and Schmidt-Hebbel (2007) assess empirically the effects of IT on long-term inflation, taking as starting point previous cross-section studies on differences in long-term inflation between ITers and non-ITers. Table 6 summarizes the results of previous studies, adding new estimates by the authors, which show that long-term inflation levels are higher in IT countries than in a stringent control group of high-performing non-IT industrial countries. The diversity of the cross-section results reported in Table 6, all based on similar specifications, illustrates the fact that empirical findings results are highly sensitive to the choice of treatment and control groups. In addition, the latter results are based on weak estimation techniques (inflation could is not instrumentalized) and the lack of the time dimension. Therefore Mishkin and Schmidt-Hebbel (2007) specify a dynamic equation for the difference in long-term inflation levels in IT and non-IT countries and estimate it using an instrumental-variable panel-data model for a large panel sample. Table 7 summarizes a

wide range of long-term inflation differences between alternative treatment and control groups. Reported differences in results confirming that the choice of treatment and control groups is key for the corresponding results. However, it is interesting to note that long-term inflation is 1.1% lower in the subset of IE ITers than in the control group of IE non-ITers, in opposition to the cross-country result by Ball and Sheridan (2005), who report no differences betweeen IE ITers and non-ITers.

Calderón and Schmidt-Hebbel (2008b) find that adopting IT and having it in place lowers inflation rates. They assess the role of non-monetary factors in determining inflation in a world panel based on the following specification:

$$(2)\quad \pi_{i,t} = \beta_0 + \beta_1 INFR + \beta_2 MERR + \beta_3 OPN + \beta_4 STIN + \beta_5 CYC + u_i + e_{i,t}$$

where π is the normalized inflation rate[9], *INFR* stands for inflation-related variables (high inflation and hyperinflation dummy variables; lagged inflation), *MERR* is a set of dummy variables for monetary and exchange rate regimes, *OPN* comprises openness variables (measures of trade and financial openness; external inflation), *STIN* is a set of structural and institutional variables (democratic accountability, per capita GDP, the fiscal surplus ratio to GDP, and the private credit ratio to GDP), and *CYC* denotes cyclical variables (the domestic and foreign output gaps; the cyclical component of international oil prices).

The panel-data estimation results for equation (2), reported in table 8, are based on a world sample of annual data covering 1975-2005 and comprising 65 countries, including both ITers and non-ITers. The main result for this paper is that having an IT regime in place lowers annual inflation by roughly 5 p.p. Note that here the control group is comprised by all non-IT countries in the world included in this study, among them many non-IT EMEs with at least moderate inflation rates.

This result is robust to using different samples, estimating techniques, and specifications that control for a sizeable number of statistically significant inflation

[9] *INF* is defined as: (annual inflation) / (1 + annual inflation).

determinants, as reported in Calderón and Schmidt-Hebbel (2008b). Other than the IT regime, significant and robust variables that reduce inflation in the world are financial openness, the fiscal balance, income per capita, the output gap, and a fixed exchange-rate regime.

Next I turn to the issue of monetary policy efficiency. Focusing only on inflation volatility – or inflation deviations from targets, as in section 3 above – is a partial and hence potentially biased way to assess efficiency of monetary policy. The usual, more comprehensive approach involves measures of both inflation and output variability. Mishkin and Schmidt-Hebbel (2008), following Cecchetti et al. (2006), solve for the minimization problem of a central-bank loss function based on inflation and output volatility, subject to a highly stylized structure of an economy reflected by aggregate demand and supply equations. Extending the previous empirical work by Cecchetti et al. applied to individual countries, Mishkin and Schmidt-Hebbel estimate the system of equations on panel data for different treatment (IT) country groups and different control (non-IT) country groups, based on quarterly data for 1989-2004. Using the parameter estimates and the model solution, they construct inflation-output variability frontiers that represent measures of economic performance and monetary policy efficiency. Supply shock variability is interpreted as a change in the position of the efficiency frontier while the efficiency of monetary policy is measured by the distance from the economy's observed volatility performance to the policy efficiency frontier.

Figure 11 depicts two efficiency frontiers and two observed points of output and inflation variability: one for inflation targeters before they adopted IT and for stationary ITers after they converged to stationary targets. The more outward efficiency frontier and observed volatility performance represents a control group of subsequent IT countries from 1986 and extending to the quarter before they adopt IT. The more inward efficiency frontier and observed volatility performance represents a treatment group of stationary-target ITers that extends from the first quarter of stationary targets through the last quarter of 2004. Figure 12 plots efficiency frontiers and observed volatility points for the treatment group of stationary ITers (again) and for the control group of non-IT economies. The main finding

represented in the two latter figures is that IT has helped to improve massively the efficiency of monetary policy of ITers but monetary policy efficiency still falls short of efficiency levels observed in the stringent control group of high-performing non-IT industrial countries.

Finally I refer briefly to the contribution of IT in attaining higher levels of central bank transparency, based on simple unconditional analysis derived from the data collected by other researchers. Policy transparency is a key issue for IT central banks as they aim at policy credibility in general and anchoring inflation expectations in particular. Eijffinger and Geraats (2006) develop an aggregate central bank transparency index based on performance indicators grouped into five measures: political transparency (related to policy objectives), economic transparency (related to information disclosure on data, models and forecasts), procedural transparency (which refers to the release of minutes and votes), policy transparency(related to the announcement and explanation of policy decisions), and operational transparency (regarding implementation of policy decisions). They apply the latter transparency measures to several industrial countries. Dincer and Eichengreen (2007) extend the latter database by including more countries and separating between ICs and EMEs.

Figure 13, borrowed from Geraats (2008), plots average transparency indexes for different country groups classified by four alternative monetary policy regimes over the period 1998-2006. ITers achieve by far the highest levels of aggregate central bank transparency among all countries pursuing different monetary regimes. Moreover, ITers have been able to raise over time the distance in transparency from countries under other regimes. Figure 14 reflects the transparency improved attained by IC and EME ITers during 1998-2005. While transparency in IC ITers is much larger than in EME ITers, the gap is narrowing over time.

5. What lies ahead for IT regimes?

I will refer to two sets of challenges that lie ahead for IT central banks. The first relates to demands for enlarging monetary policy transparency. The second set is comprised

by systemic challenges to the conduct of policy and the design of IT stems derived from questions posed by the monetary policy experience of the 2002-2009 boom-bust cycle (for more detailed discussions see Walsh 2009a, b and Hammond 2009).

The evidence discussed in this and other papers on the comparative achievements of monetary policy under IT suggests that explicit IT dominates other successful monetary regimes (including implicit IT and other monetary regimes different from explicit IT, like those pursued by the U.S. Federal Reserve, the European Central Bank, and the Bank of Japan) in several dimensions. First, IT enhances transparency and accountability more effectively as other regimes, as shown in the evidence reported by Dincer and Eichengreen (2007) and Geraats (2008). IT also provides more predictability because of less discretion in monetary policy decisions (Walsh, 2009 a,b). Third, IT guarantees better anchoring of inflation expectations (Gürkaynak et al., 2007 and De Carvalho and Minella, 2009). Finally, IT does not imply higher output volatility than other monetary regimes, as shown by Schmidt-Hebbel and Mishkin (2008), among others (as discussed by Walsh 2009a).

But many inflation-targeting central banks still face important transparency and communication challenges. First, following the advice of academics and the encouraging of several IT central banks to date, all ITers should aim at publish their interest-rate forecasts and fan charts, complementing publication of inflation and output growth forecasts and fan charts. Second, to make a clearer, more transparent connection between monetary policy decisions and published projections of central banks, they should include their backcasts and forecasts of key unobservable variables, including potential or efficient-level output (and the output gap), the natural unemployment rate (and the natural rate of unemployment), the neutral rate of interest (and the interest-rate gap), and the equilibrium exchange rate (and the deviation of the actual from the equilibrium exchange rate). Finally, while central banks have made improvements in procedural transparency, they should commit to publish timely and full transcripts (minutes) of their monetary policy meetings.

Frontier monetary policy – under both IT and other inflation regimes – is severely challenged by our current understanding of the current financial crisis cum recession and

the boom-and-bubble period that preceded it. This raises two sets of issues for monetary policy and monetary regime choice: the role of asset prices and financial frictions for monetary policy in general (not just under IT) and the design of IT.

The pre-crisis consensus view on the role of asset prices and monetary policy was that the latter should react to asset-price shocks only to the extent that they affect inflation forecasts or if the real interest rate were affected by financial shocks (Bernanke and Gertler 2001). Yet financial frictions (like real frictions) affect monetary policy transmission and interact with nominal rigidities, hence calling for monetary policy to mitigate the effects of the latter interaction.[10] The crisis has highlighted the latter role for monetary policy (as shown in recent theoretical work by Cúrdia and Woodford 2008, De Fiore and Tristani 2009, and Demirel 2009) although, as pointed out by Walsh (2009b), the appropriate monetary policy response will depend on the type of financial friction and shock.

A separate, much longer discussion has been whether central banks should lean against the wind of asset-price bubbles. Cecchetti et al. (2000), Cecchetti el al. (2002), and Borio and White (2003) have argued that monetary policy should attempt burst bubbles ex ante. Against the latter, the wide-shared consensus view was that monetary policy was too ineffective to deal with bubbles, that bubbles were difficult to identify ex ante, and that the more effective alternative would be to address the effects of a busting bubble by easing policy after the fact (Bernanke and Gertler 2001, Bernanke 2002, Gertler 2003). The latter consensus view has been seriously shattered by the massive real costs and deflationary consequences of the housing and equity price bursts observed in many industrial economies, with world-wide consequences. While this bubble-and-bust experience has also certainly other causes in many market and regulatory imperfections that require separate

[10] Walsh (2009a) makes the important point that this monetary policy acts as a second-best policy. If an effective time-varying fiscal-policy instrument (based on taxes and subsidies) were available to counteract the effects of mark-up (real) shocks, monetary policy would not be necessary to mitigate the inflation and output effects of interactions between real frictions and nominal rigidities. In the same vein, if an effective time-varying financial regulation (for example, counter-cyclical capital and liquidity requirements) were available to counteract of financial shocks, like changes in credit spreads, monetary would be not necessary to mitigate the consequences of interactions between financial frictions and nominal rigidities.

regulatory reform, it is likely to lead to changes in the conduct of monetary policy – both with and without IT – aiming at deflating incipient asset-price bubbles.

Another issue brought to the forefront by monetary policy actions during the current crisis is to come to a better theoretical and practical understanding of how conventional monetary policy – both under IT and other monetary regimes – is complemented by unconventional monetary (and credit) policy, as reflected by the massive deployment of quantitative (and credit) easing to provide liquidity to illiquid financial markets and firms.

Finally, the crisis has brought to the open the problems faced by monetary policy under conditions of severe deflationary demand shock that leads to policy rate cuts toward zero, i.e., when the zero-lower bound (ZLB) is binding.[11] Three design corrections to the actual implementation of OT in most countries could reduce the likelihood of attaining the ZLB: raising the numerical inflation target (at the cost of having higher average inflation) and adopting a core-inflation target, which exhibits less volatility around the central target value than headline inflation (at the cost of reducing the usefulness and credibility of a headline-inflation target). A final challenge for IT design is to assess the possible extension of standard policy horizons under IT (typically between 2 and 3 years) to 5 years or more, as suggested recently by Mishkin (2008). The three latter alternatives have been discussed in the literature on the start and optimal design of IT. They were largely dismissed until now but the binding ZLB and the protracted recession make their discussion relevant again.

The most radical challenge to IT comes from the proposal of adopting price level targeting (PLT). Long before the current crisis, Svensson (1999) and Vestin (2006) were among the first to evaluate seriously the relative merits and possible adoption of PLT. The latter's main theoretical advantage over IT is that the expectation that prices will return to their target level influences current inflation when price setting is forward-looking. This benefit is particularly strong when the ZLB holds and the economy is in a deflationary

[11] A radical alternative would be to lift the ZLB restriction by adopting negative policy rates. While the Sverige Rijksbank has done so by adopting a -0.25% policy rate in August 2009, it remains to be seen if such a policy can overcome operational limitations derived from the ensuing dominance of money over negative interest-bearing assets.

liquidity trap. Deflation bygones under IT are not bygones under PLT, requiring future inflation that is on average higher that the inflation target level (or the price level target trend). As this is anticipated by forward-looking agents, the likelihood of getting into a deflationary situation is lower under PLT and, when it materializes, the likelihood of getting out more quickly is larger under PLT.[12] Hence PLT is likely to emerge as a viable and possibly superior alternative to – or improvement of – IT in the future.

6. Concluding remarks

IT has come a long way since its birth two decades ago. The evidence shows that IT is not observationally equivalent to other monetary regimes used by frontier central banks (like implicit IT) or to best-practice monetary policy—neither in design nor in performance. Moreover, IT dominates alternative monetary regimes (including implicit IT and non-explicit regimes) in several dimensions. Yet the current crisis and the preceding boom-and-bubble period pose serious challenges to IT as we know it – and to the frontier conduct of monetary policy generally, under IT or other monetary regimes.

Many more emerging economies are likely to adopt a variant of IT in the future. It is also possible that some current ITers in Europe will drop out of the club as they join the Euro area. Yet the specific form that frontier best-practice IT in a broad sense – including price-level targeting – will take in the next (third) decade of its existence is far from clear now, the same way the current frontier IT regime was not anticipated at the birth of IT two decades ago.

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Table 1: Inflation Targeting Countries in the World, 1990-2008

Country	Date of Adoption	Inflation Target at the End of 2008 (%)	Definition of an Inflation Targeter according to:	
			Country Group	Inflation Targets Path
Armenia	2006	4.00	E	C
Australia	1993	2.50	I	S
Brazil	1999	4.50	E	C
Canada	1991	2.00	I	S
Chile	1991	3.00	E	S
Colombia	2000	4.00	E	C
Czech Republic	1998	3.00	E	S
Ghana	2007	5.00	E	C
Guatemala	2005	5.00	E	C
Hungary	2001	3.00	E	C
Iceland	2001	2.50	I	S
Indonesia	2005	5.00	E	C
Israel	1992	2.00	E	S
Korea	1998	3.00	E	S
Mexico	1995	3.00	E	S
New Zealand	1990	2.00	I	S
Norway	2001	2.50	I	S
Peru	1994	2.00	E	S
Philippines	2002	4.00	E	S
Poland	1999	2.50	E	S
Romania	2005	3.80	E	C
Serbia	2007	4.50	E	C
South Africa	2000	4.50	E	S
Sweden	1993	2.00	I	S
Switzerland	2000	1.00	I	S
Thailand	2000	1.75	E	S
Turkey	2006	4.00	E	C
United Kingdom	1993	2.00	I	S

Notes:

Adoption dates are taken from Leyva (2008)

Inflation targets are taken from central bank's web pages

The middle point of the target is reported when the inflation target is defined as a range

If the inflation targeting adoption date is July or later of any year t, the annual date reported is year t+1

E=emerging, I=industrial, S=stationary, and C=converging

Source: based on Mishkin and Schmidt-Hebbel (2008) and Leyva (2008).

Table 2: Determinants of the Likelihood of having an IT Regime in place

	Fixed effects		Random effects					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inflation	-130.026 ***	-117.311 ***	-35.392 ***	-36.295 ***	-43.349 ***	-36.421 ***	-39.508 ***	-33.487 ***
	(2.95)	(3.18)	(5.10)	(5.46)	(6.13)	(5.88)	(6.63)	(6.46)
Government budget balance	-25.066	-	19.307 **	20.685 **	15.040 **	17.909 **	-	-
	(1.45)	-	(2.07)	(2.31)	(1.98)	(2.53)	-	-
Financial development	19.872 ***	16.881 ***	0.775	-	3.299 ***	3.186 ***	2.633 ***	2.677 ***
	(3.07)	(3.39)	(0.55)	-	(3.19)	(3.40)	(2.99)	(3.22)
Exchange rate regime	-20.320 ***	-17.824 ***	-4.958 ***	-5.068 ***	-4.978 ***	-4.464 ***	-3.990 ***	-3.655 ***
	(3.03)	(3.22)	(5.27)	(5.54)	(7.04)	(7.20)	(7.74)	(7.49)
GDP per capita	104.027 ***	90.130 ***	5.042 ***	5.249 ***	4.605 ***	3.478 ***	4.822 ***	3.829 ***
	(3.19)	(3.56)	(4.78)	(5.29)	(5.08)	(3.49)	(5.90)	(4.19)
Trade openness	46.763 ***	42.343 ***	1.156	-	2.289 **	0.837	3.185 ***	2.134 **
	(2.83)	(3.03)	(0.82)	-	(2.06)	(0.68)	(4.01)	(2.53)
Money growth volatility	-	-	-0.142	-0.126	-	-	-	-
	-	-	(0.44)	(0.39)	-	-	-	-
Terms of trade volatility	-	-	1.760	0.959	-	-	-	-
	-	-	(0.28)	(0.15)	-	-	-	-
Dummy LAC	-	-	6.986 ***	6.741 ***	7.789 ***	-	7.433 ***	-
	-	-	(3.84)	(4.11)	(4.63)		(4.85)	-
Constant	-	-	-45.403 ***	-45.517 ***	-43.798 ***	-30.343 ***	-47.961 ***	-36.263 ***
	-	-	(5.01)	(5.27)	(5.68)	(3.44)	(7.01)	(4.57)
Observations	491	554	1143	1163	1854	1854	2305	2305
Number of countries	19	24	71	71	76	76	98	98
Countries with the IT regime	19	24	19	19	19	19	24	24
Countries without the IT regime (control group)	0	0	52	52	57	57	74	74
LR statistic	450.19	499.19	76.03	75.10	126.91	126.90	177.77	161.95
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Source: Calderón and Schmidt-Hebbel (2008).

Table 3: Marginal Contribution of Key Determinants to IT Regime Likelihood

Variable	Marginal contribution	Measure	Impact of…
CPI inflation rate	13.19%		a reduction of pi by 10 percentage points (p.p.) which amounts roughly a reduction of pi from 17% to 5%
Financial development	6.79%	ratio	an increase of the indicator by 10 p.p.
GDP per capita	65.64%	in logs	an increase of the log of GDP per capita by 1.2 which accounts for passing from 2 (8.1 Indonesia) to 3 (9.3 Poland) in income category
Trade openness	8.82%	ratio	an increase of the indicator by 10 p.p.

Notes:
The figures for Indonesia and Poland correspond to averages of the log of GDP per capita computed over the period 2001-2005.

Source: Leyva (2008).

Table 4: Measures of Inflation Deviations from Targets and Inflation Deviation in IT Countries, from IT Starting Quarter through 2008.IV

Country	Number of observations	Half-life (in months)	MAE	MSE	RMSE
Switzerland	36	11.6	0.4	0.3	0.5
United Kingdom	69	27.1	0.9	1.1	1.1
Canada	72	14.2	0.9	1.3	1.1
Sweden	56	25.3	1.1	1.6	1.3
Norway	32	8.0	1.1	2.0	1.4
New Zealand	76	20.1	1.1	2.0	1.4
Australia	64	20.0	1.1	2.1	1.4
Colombia	37	15.7	1.2	2.8	1.7
Romania	14	-	1.3	2.9	1.7
Korea	44	18.9	1.1	3.1	1.8
Thailand	36	23.2	1.2	3.1	1.8
Chile	72	14.7	1.1	3.1	1.8
Philippines	28	29.3	2.1	5.1	2.3
Czech Republic	44	14.4	1.7	5.8	2.4
Poland	42	24.4	2.0	6.1	2.5
Israel	68	14.6	2.1	7.0	2.6
Guatemala	16	14.5	2.2	7.1	2.7
Iceland	32	16.6	2.2	8.1	2.8
Armenia	12	6.8	2.5	8.2	2.9
Peru	60	9.1	1.7	8.5	2.9
Hungary	32	18.4	2.3	9.2	3.0
South Africa	36	24.7	2.4	9.5	3.1
Serbia	10	24.9	3.6	19.4	4.4
Brazil	40	22.6	2.9	19.4	4.4
Mexico	56	7.6	2.8	24.6	5.0
Turkey	12	7.1	4.9	25.3	5.0
Indonesia	16	10.3	3.9	30.4	5.5
Ghana	8	-	6.2	40.1	6.3

Notes:

Sample comprises inflation targets and inflation rates from the start of IT in each country until the fourth quarter

of 2008

Half-life of an inflation deviation are defined as the number of periods that a given inflation deviation from target takes

to converge to one-half its initial value
Half-lives are computed asumming that the best autoregressive process for inflation deviations for each country is an AR(1)

MAE=Mean absolute error

MSE=Mean squared error

RMSE=Root mean squared error

Source: author's calculation based on central bank and IMF data.

Table 5: Determinants of Inflation Deviations from Targets, Panel of 19 IT Countries, 1990-2003

	(1) AD1	(2) AD2	(3) AD3	(4) AD1	(5) AD2	(6) AD3	(7) AD1	(8) AD2	(9) AD3
c	1.444	0.860	1.147	1.914	1.294	1.880	1.962	1.277	1.925
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
ABS(AD1(-1))	0.800	0.876	0.871	0.725	0.844	0.824	0.724	0.822	0.824
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ABS(AD1(-2))	-0.191	-0.246	-0.195	-0.190	-0.261	-0.186	-0.190	-0.225	-0.185
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ABS(AD1(-3))	-0.055		-0.076	-0.087		-0.104	-0.088	-0.059	-0.104
	(0.104)		(0.037)	(0.016)		(0.004)	(0.016)	(0.098)	(0.004)
ABS(NER)		0.009	0.009						
		(0.022)	(0.031)						
ABS(NER(-1))	0.015			0.012	0.009	0.010	0.012	0.009	0.011
	(0.000)			(0.007)	(0.039)	(0.019)	(0.007)	(0.043)	(0.018)
ABS(OILG)	0.007	0.007	0.006	0.007	0.007	0.006	0.007	0.007	0.006
	(0.020)	(0.013)	(0.035)	(0.018)	(0.013)	(0.025)	(0.018)	(0.009)	(0.025)
ABS(OILG(-1))	-0.010	-0.010	-0.006	-0.010	-0.010	-0.006	-0.010	-0.010	-0.006
	(0.006)	(0.002)	(0.065)	(0.005)	(0.001)	(0.049)	(0.005)	(0.002)	(0.049)
ABS(OILG(-2))	0.009	0.006	0.006	0.008	0.006	0.005	0.008	0.005	0.005
	(0.002)	(0.016)	(0.049)	(0.004)	(0.021)	(0.063)	(0.003)	(0.044)	(0.062)
ABS(GAP(-3))	-0.040		-0.033			-0.025			-0.025
	(0.005)		(0.024)			(0.108)			(0.104)
CBI	-0.161	-0.149	-0.144						
	(0.010)	(0.007)	(0.015)						

IICR	-0.011	-0.007	-0.010	-0.020	-0.012	-0.020	-0.021	-0.011	-0.021
	(0.000)	(0.000)	(0.000)	(0.002)	(0.034)	(0.001)	(0.002)	(0.063)	(0.001)
R2	0.51	0.58	0.59	0.53	0.61	0.62	0.53	0.58	0.62
Adj. R2	0.50	0.57	0.58	0.50	0.59	0.60	0.50	0.55	0.60
U-root test	-22.02	-21.56	-21.84	-22.26	-21.58	-21.46	-21.46	-22.09	-18.10
N	517	536	517	517	536	517	517	517	517
Intercept	C	C	C	F-effects	F-effects	F-effects	F-effects	F-effects	F-effects
Method	OLS	OLS	OLS	OLS	OLS	OLS	TSLS	TSLS	TSLS

Source: Albagli and Schmidt-Hebbel (2008).

Table 6: Estimates of Differences in Long-Term Inflation Rates between IT and Non-IT Countries in Four Cross-Section Studies

Authors	Sample	Method	Long-term Inflation-level Differences (in percentage points)
Ball and Sheridan (2005)	ICs: 7 IT, 13 NIT	Cross-section OLS	Zero[a]
Vega and Winkelried (2005)	World: 23 IT, 86 NIT	Propensity Score	(-2.6 , -4.8)[b]
IMF (2005)	EMEs: 13 IT, 22 NIT	Cross-section OLS	-4.8
Mishkin and Schmidt-Hebbel (2007)	21 world IT, 13 ICs	Cross-section OLS	1.2

Notes:
a. Zero means statistically zero
b. Denotes an interval for inflation-level differences

ICs denotes inflation converging ITers

OLS=Ordinary Least Squares

Table 7: Estimates of Differences in Long-Term Inflation Rates between Different Groups of IT and Non-IT Countries, Panel-Data Results

Long-term Inflation-level Differences (in percentage points)

Treatment Group / Control Group	Method	NIters and pre-ITers	Non-ITers	pre-ITers
All ITers	OLS	-1.9	zero[a]	-5.0
All ITers	IV	-4.8	zero	-5.0
Industrial ITers	IV	zero	-1.1	zero
Emerging ITers	IV	-7.5	zero	-6.4
Stationary ITers	IV	-2.1	zero	zero
Converging ITers	IV	-8.0	zero	-8.2

Notes:

a. Zero means statistically zero

OLS=Ordinary Least Squares

IV=Instrumental Variable Estimator

Source: Mishkin and Schmidt-Hebbel (2008).

Table 8: Determinants of Inflation in the World, Panel-data Results

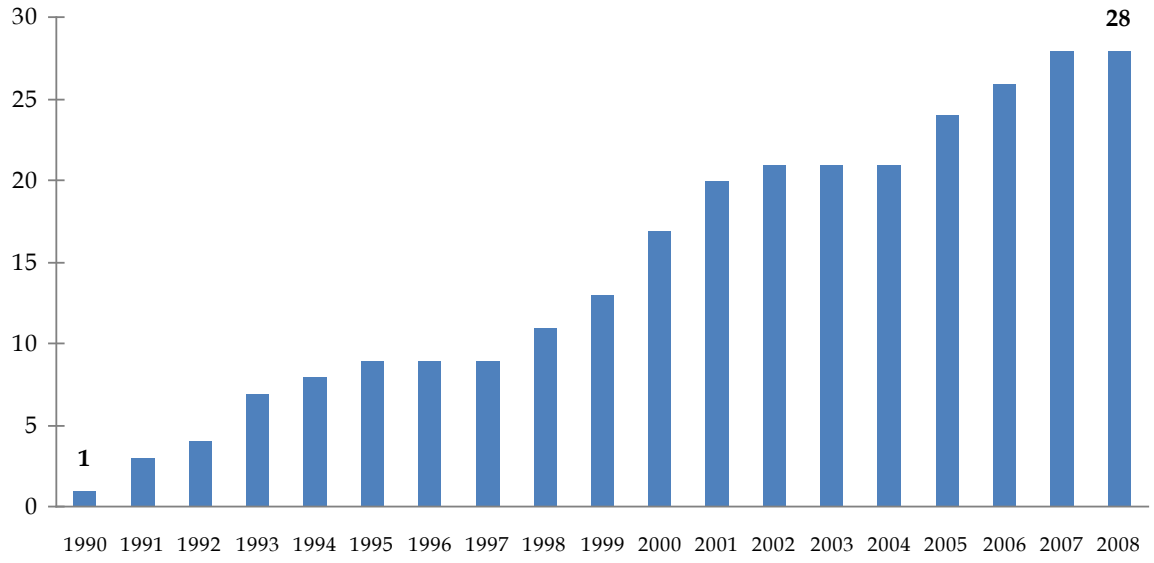
Table 3
Determinants of Inflation
Dependend Variable: Normalized Inflation
Estimation: Fixed Effects with Instrumental Variables
Sample. 1975-2005 (annual data)

	Fixed Effects and Random Effects Instrumental Variables Estimates				
	(1)		(2)	(3)	(4)
	FE IV	RE IV	FE IV	FE IV	FE IV
Inflation Related Variables					
Lagged Inflation	0.160 ***	-0.033	0.196 *	0.141	0.139
Normalized and Instrumented value	(1.97)	(0.22)	(1.87)	(1.42)	(1.39)
Hyper Inflation	0.348 ***	0.488 ***	0.357 ***	0.363 ***	0.364 ***
	(9.29)	(6.54)	(8.24)	(8.83)	(8.82)
High Inflation	0.232 ***	0.308 ***	0.226 ***	0.230 ***	0.232 ***
	(14.02)	(8.29)	(11.14)	(11.85)	(11.72)
Monetary and Exchange-Rate Regime					
Inflation Targeting	-0.051 ***	-0.045 ***	-0.051 † ***	-0.054 † ***	-0.055 † ***
Lagged († Not lagged but Instrumented)	(5.41)	(4.25)	(3.80)	(4.16)	(4.27)
Exchange Rate Regime	-0.029 ***	-0.037 ***	-0.031 ***	-0.033 ***	-0.033 ***
Lagged († Not lagged but Instrumented)	(7.70)	(5.97)	(6.77)	(7.70)	(7.82)
Openness					
Trade Openness	-0.009	-0.012 **	-0.019	-0.010	
Lagged († Not lagged but Instrumented)	(0.81)	(2.15)	(1.43)	(0.73)	
Capital Openness	-0.013 ***	-0.011 ***	-0.013 ***	-0.013 ***	-0.013 ***
Lagged († Not lagged but Instrumented)	(5.94)	(4.90)	(4.79)	(5.09)	(5.06)
Relevant External Inflation	0.210 ***	0.412 ***	0.169 **	0.080	0.127
Normalized	(3.11)	(4.77)	(2.10)	(0.96)	(1.57)
Structural / Institutional Variables					
Fiscal Surplus	-0.204 ***	-0.179 ***	-0.251 ***	-0.459 † ***	-0.427 † ***
Lagged († Not lagged but Instrumented)	(5.30)	(4.46)	(5.17)	(5.15)	(5.00)
Income per capita	-0.040 ***	0.012 ***	-0.045 ***	-0.051 † ***	-0.047 † ***
Lagged († Not lagged but Instrumented)	(3.67)	(3.09)	(3.46)	(4.06)	(4.20)
Domestic Private Credit	0.018 *	-0.059 ***	0.028 **	0.025 **	0.024 **
Lagged († Not lagged but Instrumented)	(1.87)	(4.65)	(2.37)	(2.26)	(2.29)
Democratic accountability	-0.002	-0.003 *	-0.002	-0.002	
	(1.22)	(1.65)	(1.05)	(0.74)	
Cyclical Domestic and Foreign Variales					
Cyclical component of oil prices	0.019 **	0.017	0.013	0.026 **	0.021 **
	(2.01)	(1.48)	(1.14)	(2.34)	(2.05)
National Output Gap	0.238 ***	0.057	1.182 † ***	0.724 † **	0.709 † **
Lagged († Not lagged but Instrumented)	(3.60)	(0.55)	(3.06)	(2.07)	(2.02)
Foreign output gap (weighted by GDP)	-0.204	-0.406	-0.565 **	-0.366	
	(0.93)	(1.40)	(2.11)	(1.45)	
Constant	0.467 ***	0.086 ***	0.504 ***	0.557 **	0.512 ***
	(4.80)	(3.68)	(4.47)	(5.09)	(5.22)
Hausman test (RE vs FE) *p-value*	0.00		0.00	0.00	0.00
Observations	1574	1574	1574	1570	1619
Number of Country number	65	65	65	65	65
R2 Overall	0.75	0.79	0.71	0.68	0.69

Note 1 : Absolute value of t statistics in parentheses
* significant at 10%, ** significant at 5%, * significant at 1%
Note 2: The Hausman test favors FE regressions in all cases. Thus RE, being inconsistent, is no reported from equation 2

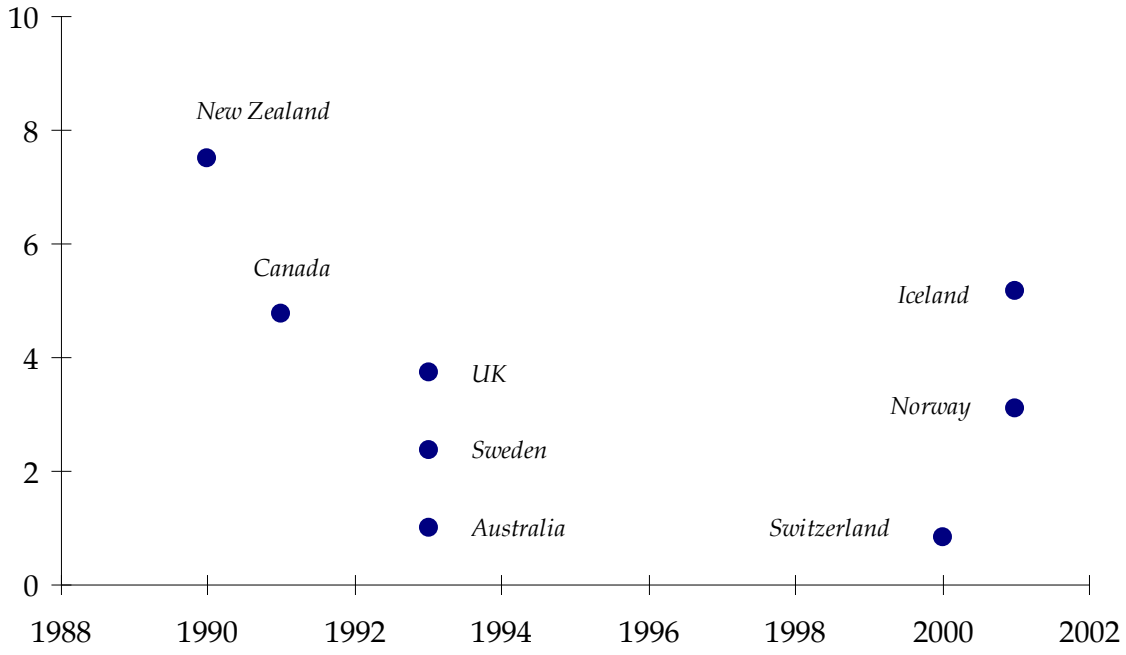
Source: Calderón and Schmidt-Hebbel (2008).

Figure 1: Number of Inflation-Targeting Countries, 1990-2008



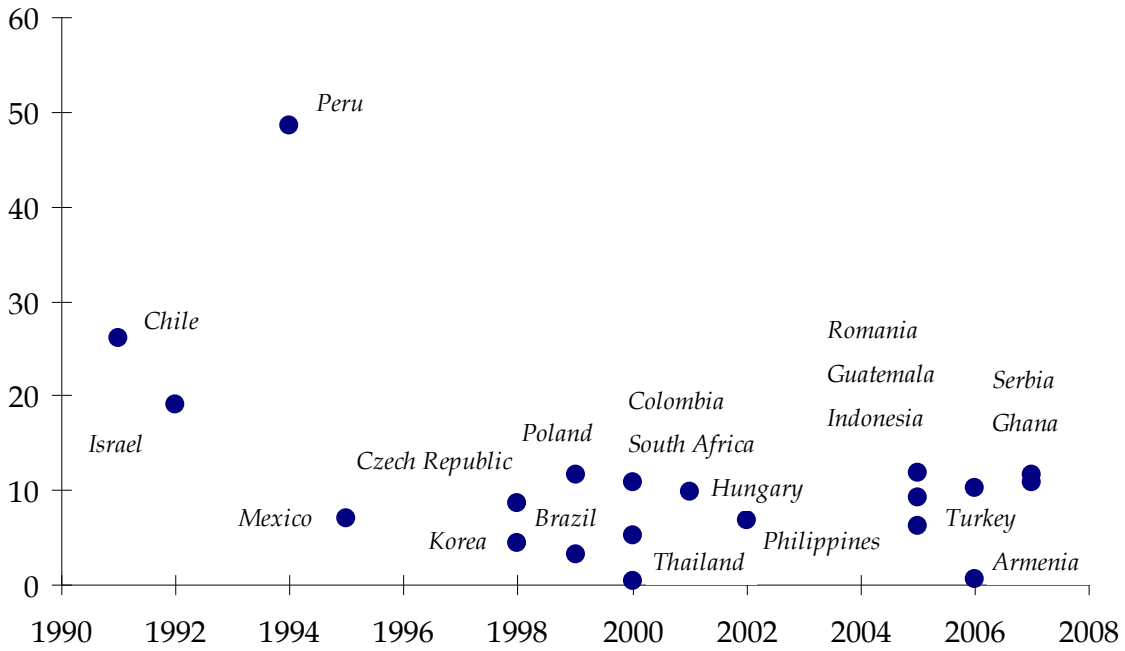
Source: Mishkin and Schmidt-Hebbel (2008) and Leyva (2008).

Figure 2: Dates of IT Adoption and Annual Inflation before IT Adoption, Industrial Economies, 1990-2001 (percent)



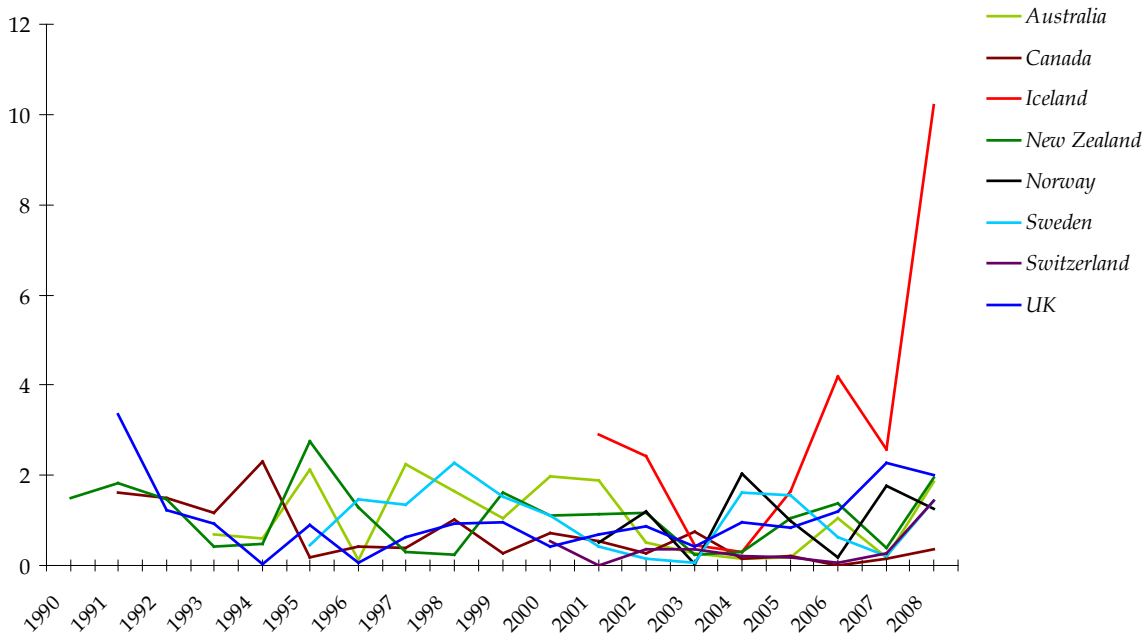
Note: depicted points reflect annual inflation rates during the 12 months that precede the month of IT adoption.
Source: author's calculation based on IMF data.

Figure 3: Dates of IT Adoption and Annual Inflation before IT Adoption, Emerging Market Economies, 1991-2007 (percent)



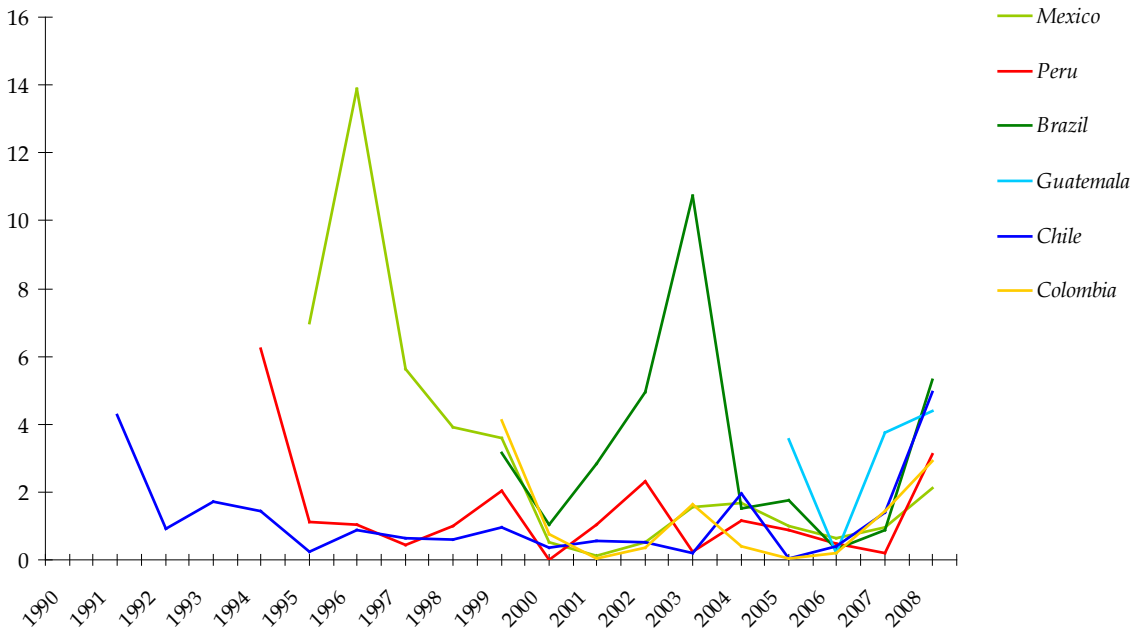
Note: depicted points reflect annual inflation rates during the 12 months that precede the month of IT adoption.
Source: author's calculation based on IMF data.

Figure 4: Annual Absolute Inflation Deviations from Targets in Industrial Economies, 1990-2008 (percentage point)



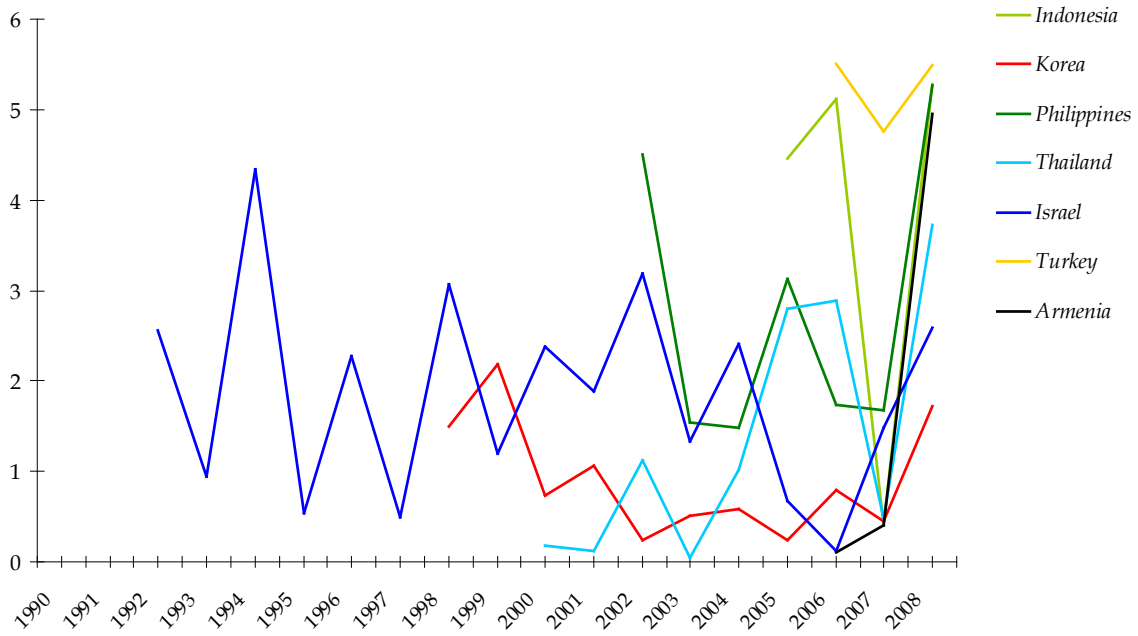
Source: author's calculation based on central bank and IMF data.

Figure 5: Annual Absolute Inflation Deviations from Targets in Latin American Economies, 1991-2008 (percentage point)



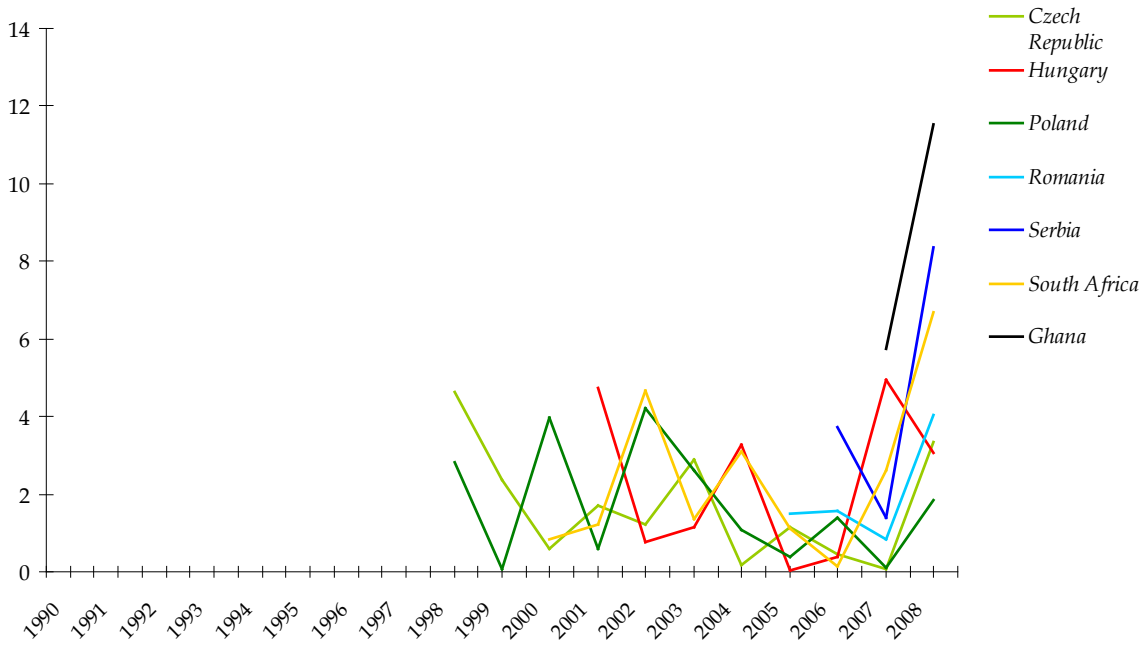
Source: author's calculation based on central bank and IMF data.

Figure 6: Annual Absolute Inflation Deviations from Targets in Asian Economies, 1992-2008 (percentage point)



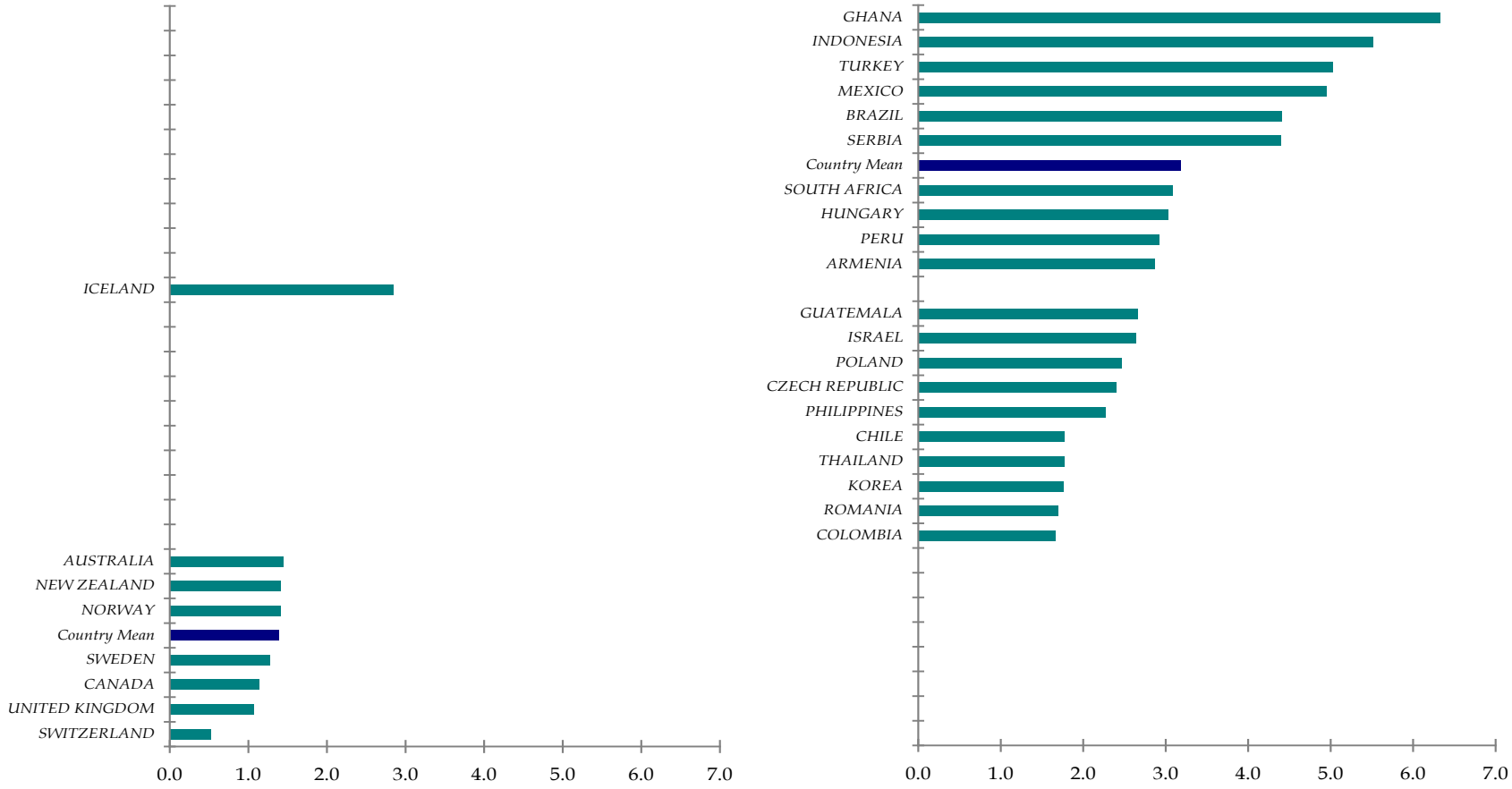
Source: author's calculation based on central banks and IMF data.

Figure 7: Annual Absolute Inflation Deviations from Targets in Central-Eastern European and African Economies, 1998-2008 (percentage point)



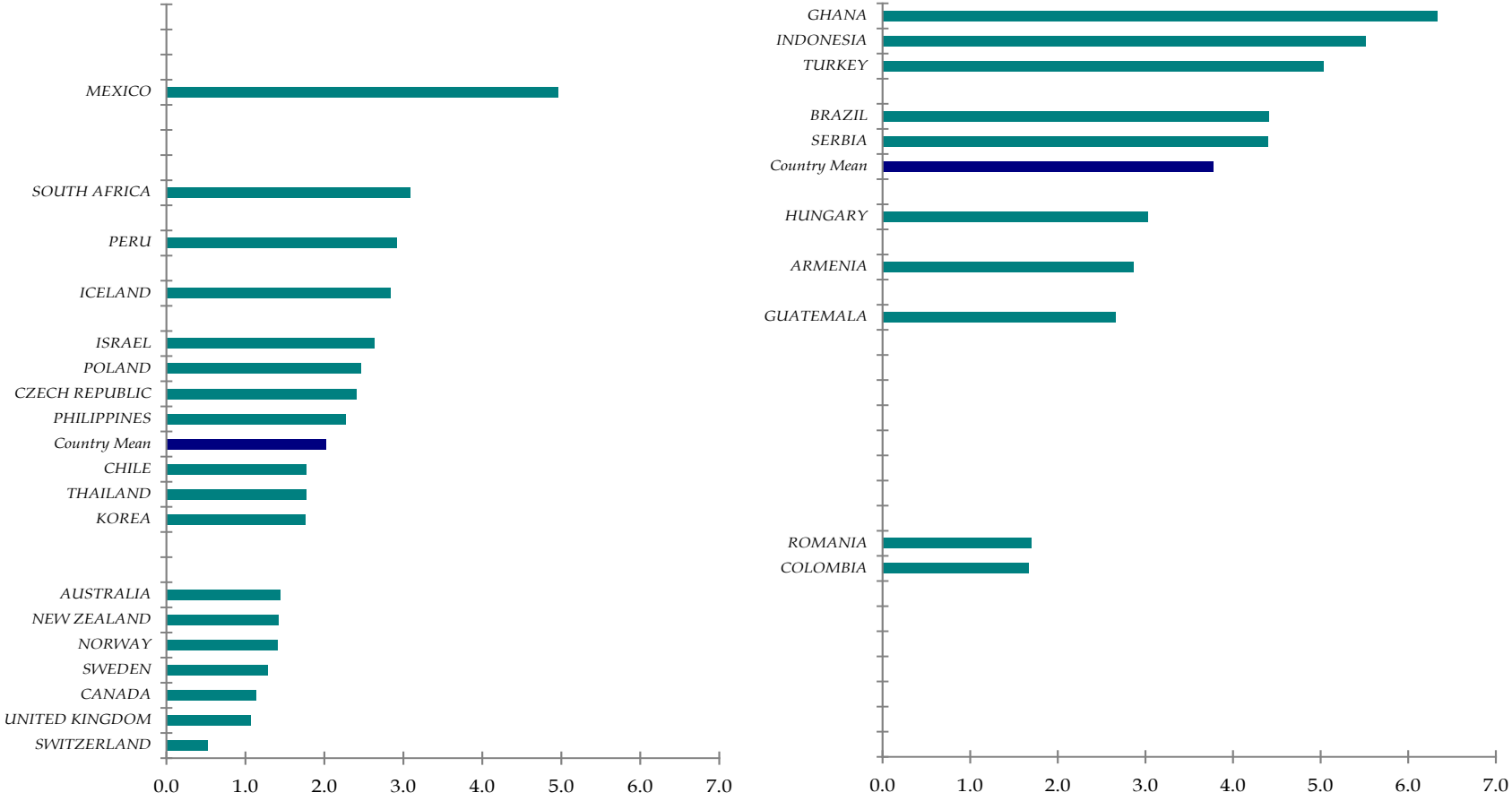
Source: author's calculation based on central bank and IMF data.

Figure 8: Inflation Deviations from Targets measured by Root Mean Squared Errors in Industrial and EME Inflation Targeters, 1990-2008



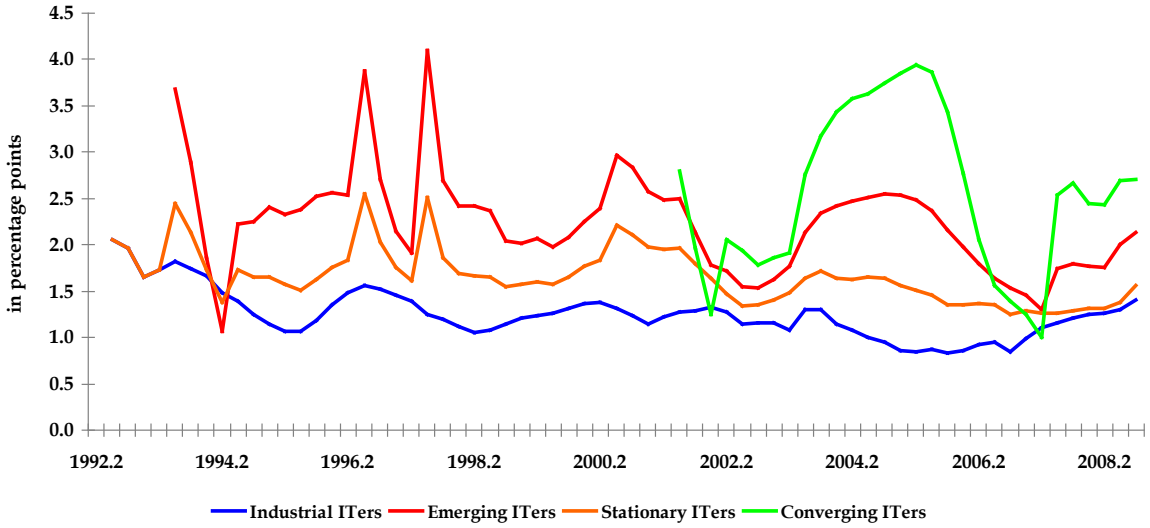
Note: Left panel: industrial-country ITers; right panel: emerging-market economy ITers. Source: author's calculation based on central bank data.

Figure 9: Inflation Deviations from Targets measure by Root Mean Squared Errors in Stationary and Converging Inflation Targeters, 1990-2008



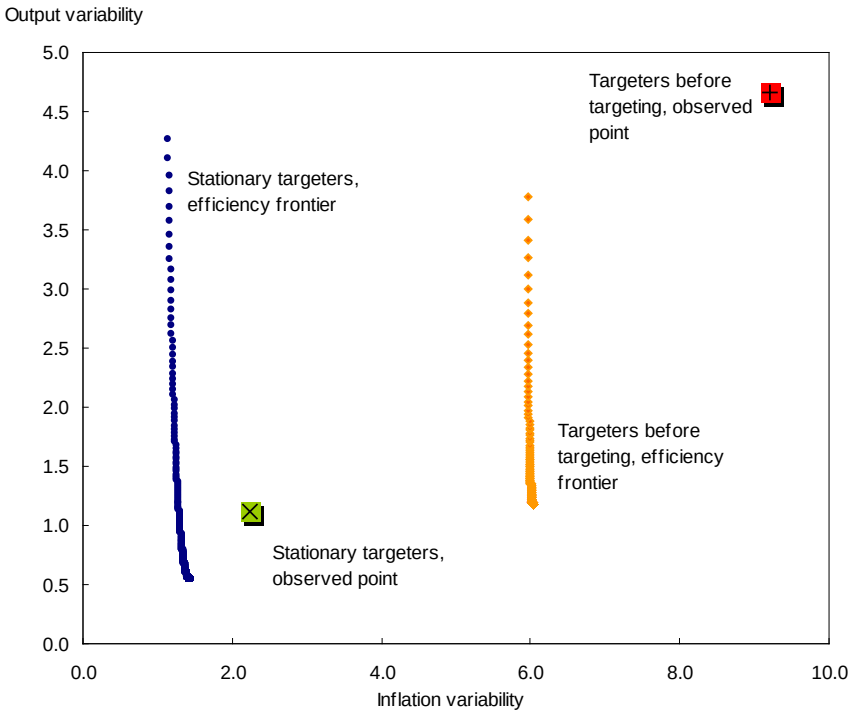
Note: Left panel: stationary ITers; right panel: converging ITers. Source: author's calculation based on central bank data.

Figure 10: Rolling Estimation of Root Mean Squared Errors in Groups of IT Countries, 1990-2008 (8-quarter windows)



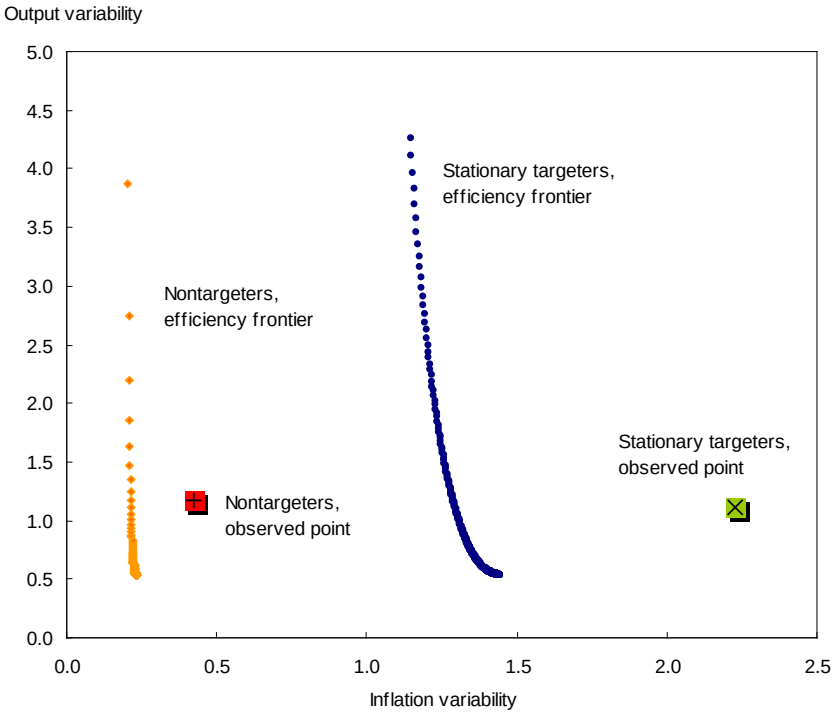
Note: Rolling series for inflation deviations from target for each country group correspond to the simple average of inflation deviations for each country member.
Source: author's calculation based on central bank data.

Figure 11: Efficiency Frontiers and Observed Inflation and Output Volatility in IT Countries before IT Adoption and in Stationary-target IT Countries (percent)



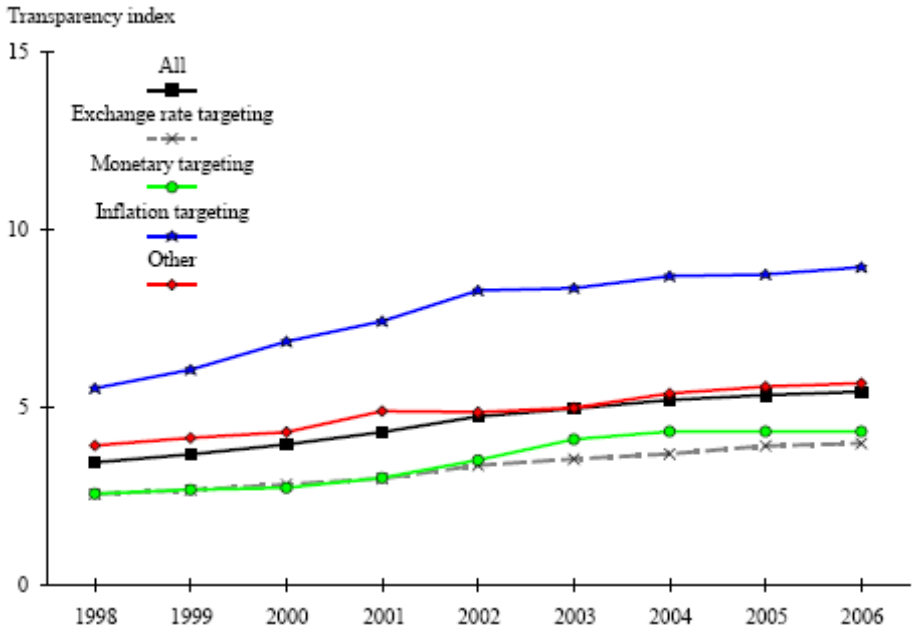
Source: Mishkin and Schmidt-Hebbel (2008).

Figure 12: Efficiency Frontiers and Observed Inflation and Output Volatility in Non-IT Countries and in Stationary-target IT Countries (percent)



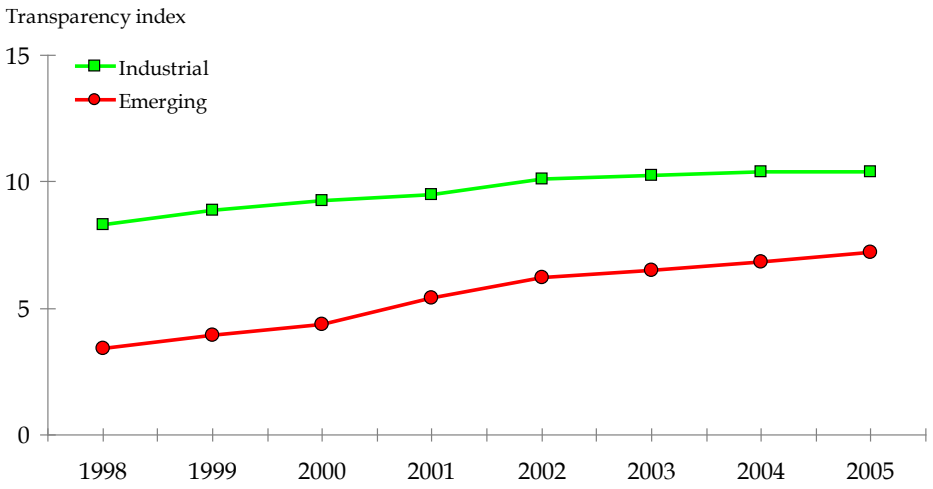
Source: Mishkin and Schmidt-Hebbel (2008).

Figure 13: Central Bank Transparency Index for Country Groups by Monetary Policy Regimes, 1998-2006



Source: Geraats (2008), based on data by Dincer and Eichengreen (2007).
Note: the transparency index ranges from 0 (least transparent) to 15 (most transparent).

Figure 14: Central Bank Transparency Index for Industrial and EME IT Country Groups, 1998-2005



Source: Geraats (2008), based on data by Dincer and Eichengreen (2007).
Note: the transparency index ranges from 0 (least transparent) to 15 (most transparent).