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DIPLOMOVÁ PRÁCE

Two Essays on Inflation Targeting

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Děkuji Romanovi Horváthovi, PhD. za mnoho inspirace i detailní komentáře a celkově podnětné vedení při psaní práce. Vekeré chyby nepřesnosti jsou mé vlastní.

Prohlasuji, ze jsem svou diplomovou práci napsal samostatně a výhradně s pouzitím citovaných pramenů. Souhlasím se zapůjčováním práce a jejím zveřejňováním.

V Praze dne Jakub Matějů

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Název práce: Dva eseje o cílování inflace
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Abstrakt:
Práce sestává ze dvou esejů o cílování inflace. První esej zkoumá, jak centrální banky určují své inflační cíle. Prezentován je přehled komunikace centrálních bank ohledně inflačních cílů, dále je zkoustruován teoretický model a nakonec je provedena panelová empirická analýza zemí cílujích inflaci. Tato první analýza daného problému vede k závěru, ze inflační cíle jsou ovlivněny více proměnnými nez centrální banky přiznávají. Kromě vlivu minulé a zahraniční inflace, variability inflace a růstu HDP nacházíme signifikantní vliv kredibility centrální banky a dalsích institucionálních faktorů. Krátký druhý esej se zabývá perspektivami cílování inflace jako rámce pro měnovou politiku a zároveň je přehledem dosavadní literatury hodnotící cílování inflace. Závěrem je, ze pokud budou centrální banky cílující inflaci pokračovat v důrazu na transparentnost a komunikaci a zároveň zůstanou otevřeny inovacím, cílování inflace má vysoké sance uspět i v období krize.

JEL Klasifikace: E31, E52, E58
Klíčová slova: cílování inflace, monetární politika

Title: Two Essays on Inflation Targeting
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Abstract:
The thesis consists of two essays on inflation targeting. The first essay examines how do central banks set their inflation targets. Survey of central banks' communication regarding the target is presented, theoretical model is developed and finally empirical analysis is conducted on a panel of inflation targeting countries. This pioneering analysis of the topic leads us to conclusion that inflation targets are influenced by more variables than central banks admit. In addition to past and foreign inflation, inflation variability and GDP growth we find significant impact of central bank credibility and other institutional factors. The short second essay surveys literature assessing performance of inflation targeting and outlines perspectives of inflation targeting as a monetary policy framework. The conclusion is that if inflation targeting central banks stick to their best practice in transparency and communication and remain open to innovations, inflation targeting will have a good chance to score well even in the periods of turmoil.

JEL Classification: E31, E52, E58
Keywords: inflation targeting, monetary policy

...to Jana, who does not care about inflation targeting at all

Chapter 1

How Do Central Banks Set Their Inflation Targets?

1.1 Introduction

1.1.1 Inflation Targeting and Inflation Targets

Inflation targeting (IT) has become an increasingly popular monetary policy regime during the last twenty years. After the pioneering New Zealand adopted inflation targeting in 1989, other countries soon followed: Canada and Chile in early 1991, Israel and United Kingdom in 1992 and Finland and Sweden in 1993 led the league. Gradually, many more adopted the policy framework of IT. For example, several post-soviet emerging market economies like Czech Republic and Poland took advantage of IT during the disinflation process.

Inflation targeting, more precisely called inflation *forecast* targeting, is characterized by transparent communication of inflation target and a commitment to drive the interest rate trajectory (and in exceptional cases also exchange rate) to meet the target. As monetary policy faces significant transmission lags, the inflation targeting practice is to rely on forecast. As a result, the forecast itself is targeted by monetary policy as a mean of expected inflation distribution.

Unlike other monetary policy frameworks, namely exchange rate peg or money supply growth control, which have been discussed thoroughly by academics prior to implementing as an active policy, inflation targeting was at first adopted with no theory behind, as a ad-hoc measure to overcome high and unstable inflation rate.

The theory of modern inflation targeting began to being built first in mid 90's (Svensson's (1998) seminal paper), while the most significant contributions came in late 90's. As a result, many questions remain unresolved until today. One of them is "How do central banks set their inflation targets?"

The dispute over efficiency and sustainability of IT remains open. Many point out that inflation targeting helped countries keep inflation at desirable low and stable levels,

while maintaining solid growth rates. (Mishkin and Schmidt-Hebbel (2001, 2006), Walsh (2008)) Others (Ball and Sheridan (2005)) argue that almost all countries managed to considerably lower inflation rates during observed period and claim that inflation targeters did not perform better than non-targeters. Overall, the common accepted view is that IT *did not* worsen economic performance: did not cause more volatile output gap as feared. The non-failure view is also supported by the fact that no country has abandoned inflation targeting so far (apart from Finland and Spain entering the Eurozone).

Regardless of successful or not, IT has brought several bonuses to both academia and policymakers in general. Inflation targeting (more precisely, inflation forecast targeting) relies heavily on inflation forecast as an intermediate target variable. Not surprisingly then, this monetary policy framework contributed significantly to development of high quality, computer-intensive macroeconomic forecasts, usually based on DSGE models.

Second major contribution to both economic theory and policy is increased focus on central bank transparency and communication. Most importantly, inflation targeting means setting a strong nominal anchor: inflation target. It also involves commitment of central bank to behave accordingly to the goal. This helps to steer inflation expectations towards the target (there is a lot of research illustrating the effect, see for example van den Cruijsen and Demertzis (2007)). Mishkin (2006) argues that "the strengthening of the nominal anchor apparently helps move the economy toward the efficient frontier of the trade-off between inflation and output gap variability, generating better performance on both the inflation and output fronts." Publishing inflation reports, economic forecasts, MPC meeting minutes, giving speeches and press conferences after policy decisions has become common practice not only for inflation targeting central banks. Despite these favorable changes in monetary policy transparency, there is still an important issue in which the central bankers often remain silent: "How do central banks set their inflation targets?"

For example, National Bank of Poland in it's "Medium-Term Strategy of Monetary Policy (1999-2003)" writes "The Council has decided that the medium-term target of monetary policy will be to reduce inflation to below 4% by the year 2003." with no further explanation.

Further, Mervyn King, Governor of Bank of England, in his speech on the occasion of inflation target change said "From May 1997 the target was 2.5% for RPIX inflation. But in December the Chancellor gave the Monetary Policy Committee a new target for inflation. It is 2% as measured by the Consumer Prices Index", further explaining difference between RPIX and CPI measurement. No single word is given to explain rationale behind the particular target rate.(King (1997)) Gordon Brown, Britain's Chancellor of Exchequer by that time, did not explain the particular target value either. (Brown (1997))

However, some pieces information could be extracted from the scarce explanations of new inflation targets. We will survey the central banks' comments on inflation targets chosen later in the text.

The thesis proceeds as follows. First section establishes a crucial connection with theory of optimal inflation, presents some stylized facts and surveys the central banks communication regarding inflation targets. In the second part we build a model of central bank political economy to structure the problem and suggest possible determinants of

inflation targets. Third section presents the empirical survey testing the former hypotheses. Fourth section concludes.

1.2 Determinants of Inflation Targets: State of Art

Although there has not been virtually any discussion on how central banks set their inflation targets, the topic is to some extent overlapping with theory of optimal inflation. Although we will see that inflation target does not generally equal optimal inflation, it is crucially important to look what the optimal inflation theory has to offer us.

1.2.1 Optimal Inflation

There has been considerably more research on what rate of inflation is socially optimal. The classical treatment of the topic is presented by Milton Friedman (1969). Friedman noticed, that people tend to hold money for carrying out transactions. Holding of money naturally means opportunity cost: lost interest if they invested the money in interest-bearing assets. Friedman suggested to deflate money supply at a rate close to the real interest rate: this would ensure that holding transaction money would be virtually costless, as the price of money will rise with the same pace as value of investment. This result is equivalent to proposed paying interest of money, although with painful side-effects of deflation. Friedman's proposition is, however, rather irrelevant today, as it is based on assumption of money neutrality. Today's consensus is that deflation dampens real economic activity.

Further considerations stress the importance of inflation tax. Phelps (1976) argues, that inflation tax is one of the crucial revenues of the government and that other distortionary taxes would have to be raised in case of Friedman's proposed deflation.

McCallum (1986) sets up an OLG model and maximizes social welfare to get the optimal inflation rate. He comes to the same conclusion as Friedman: nominal interest rate should be set to zero, which means deflation at the real interest rate.

However, these classic discussions are of little relevance for modern monetary policy, as governments are nowadays generally unable to "print money", central banks are independent and deflation is one of the most feared crevasses due to various reasons, namely liquidity trap and deflation spiral, constraints on monetary policy, dampening effect on consumption, growing public debt.

More recent discussion settled down on consensus that optimal inflation is low, but positive. For example, Billi and Kahn (2008) from Kansas City Fed survey the literature on optimal inflation for the United States. The major trade-off is between costs of inflation and risks (and possible costs) of deflation.

Inflation Costs

Textbook list of major costs of inflation suggests keeping the inflation at a lowest possible rate:

- Menu costs: costs associated with changing prices
- Shoe-leather costs: costs of "going to the bank for money" (as holding it is costly)
- Redistribution from creditors to debtors, especially when unexpected
- Suboptimal planning: high inflation tends to be unstable, which makes planning difficult at best
- Disinflation costs: reducing inflation from high levels is costly in terms of unemployment and output

These reasons speak for keeping inflation close to zero. However, targeting inflation at zero does not seem to be the optimal policy either.

Deflation Threat

Risks of falling to deflation grow with inflation getting closer to zero. Deflation is not a favorable state of economy due to number of reasons:

+ Monetary policy bound: nominal interest rate can not be set below zero (lowest possible real policy rate equals inflation)
+ Deflationary trap/spiral: wage- and price-setters start to expect negative inflation and monetary policy is unable to expand money supply via lower interest rates
+ Lower investment: as value of debts grow, entrepreneurs are less willing borrow, debt is generally less available (balance-sheet effects)
+ Lower consumption: as prices fall, people tend to postpone consumption waiting for better deals

Deflation could lead to prolonged periods of sluggish economic growth with self-fulfilling negative inflation expectations causing every policy attempt to fall flat. Monetary policy is impotent due to zero bound, fiscal policy is constrained by rising debt and mitigated by preference of liquidity. We have seen the hopeless fight of Japan during the 90's.

Generally, deflation is not where a policymaker wants the economy to be. Deflationary risks are naturally negatively related to the actual rate of inflation. They are also positively related to the volatility of inflation in recent years or, more precisely, to the magnitude of shocks hitting the price level. The conclusion is that the higher the variance of inflationary shocks, the higher will be the optimal level of inflation.

Other Factors

There are several other important factors, pushing the optimal rate of inflation in upward direction:

+ Labor market grease: nominal wages are sticky downwards and positive inflation is often an only possibility how to lower real wages

+ Measurement error: price indices are usually upward biased. The index is not able to substitute in real time as consumers do and inflation is overstated as a result

Overall, the agreement is that inflation should be kept at low but positive level. Billi (2007) estimates simple New Keynesian structural model of United States Economy and maximizes social welfare. The resulting optimal inflation ranges between 0.7% and 1.4%, depending on degree of uncertainty. This finding strengthens the conclusion about importance of inflationary shocks.

Other suggestions of optimal inflation rate for the U.S. surveyed by Billi and Kahn (2008) concentrate between 1% and 2%, stressing either of the above arguments.

From the other recent studies, Camba-Méndez, García and Palenzuela (2003) from ECB review the consensus about low but positive inflation for the Euro area. They find that costs of inflation are on the one hand "even higher than previously thought" with on the other hand traditional arguments for positive inflation (in their paper this means labor market grease and inflation variability in the Euro area) are of "minor relevance".

To conclude, optimal inflation theory suggests low and positive inflation rate, while the major factor of variance among countries and over time is different level of uncertainty, particularly intensity of shocks to price level.

But do the inflation targets always equal rates suggested by optimal inflation theory? Generally no, although there is a close relation.

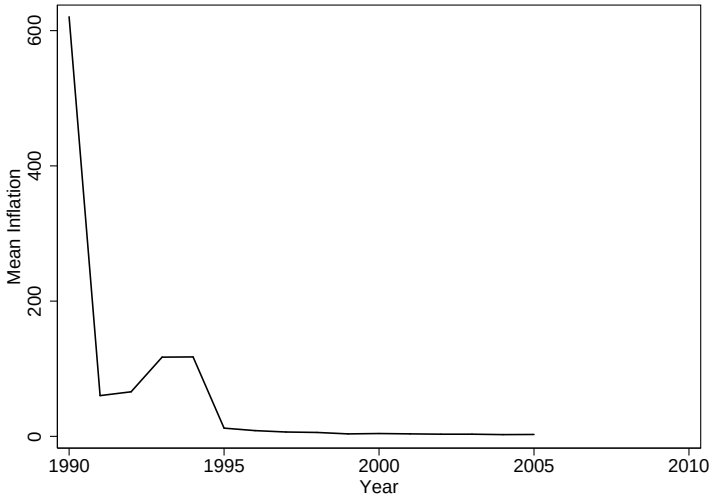
1.2.2 Some Stylized Facts

Inflation

During last twenty years, the inflation rates decreased by a substantial amount in majority of observed countries. The contribution of inflation targeting is still subject to discussion, as the trend of lowering inflation was common for both inflation targeters and non-targeters. However, this is not the purpose of this essay and we are leaving the dispute to others.

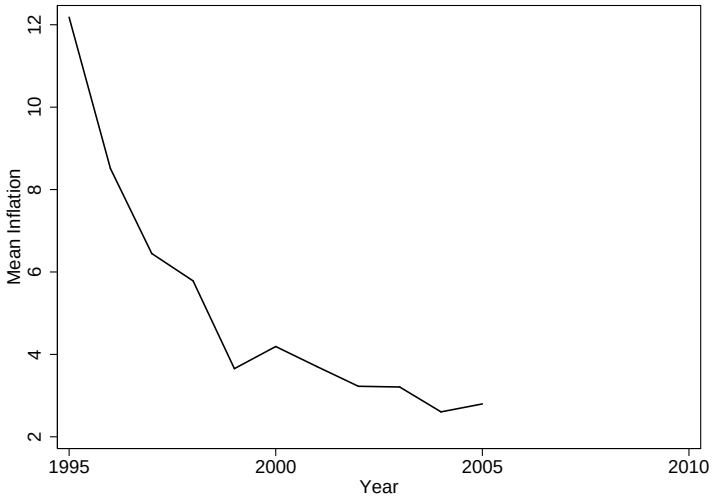
On our sample of 19 inflation targeting countries (including pre-targeting periods) the mean inflation rate was reduced from horrifying several hundred percent in 1990 to below 3% in 2005. The extreme values at the beginning of the sample is driven by hyperinflations in Brazil and Peru with non-negligible contributions of Central European economies, while the end suggests that inflation targeters managed to steer inflation to more desirable levels. Moreover, none of the countries did not experience return of hyperinflation or even high inflation period after adopting IT.

Figure 1.1: Mean Inflation in 19 IT Countries, 1990-2005



Data source: SourceOECD. Yearly data.

Figure 1.2: Mean Inflation in 19 IT Countries, 1995-2005



Data source: SourceOECD. Yearly data.

Table 1.1: Inflation in IT Countries

	1990	1995	2005
IT's Mean Inflation	620.45	12.18	2.80
Cross-sectional S.D. of Inflation	1795.78	15.52	1.52
World Inflation	18.9*	15.0	3.8
Developed Countries Inflation	5.5*	4.2	2.7

Data source: SourceOECD, Federal Reserve of Cleveland, Author's calculations

*data for 1991 (1990 not available)

Even more convenient illustration of the convergence experienced during 90's and beyond we get by cutting the sample in 1995 and showing the development without bias caused by early hyper-inflations.

For comparison we present data on world inflation and inflation in developed countries. We can see that fall in inflation rates is rather a general phenomenon during the observed period, enjoyed by both inflation targeters and non-targeters (Mojon and Ciccarelli (2005) show that the portion of inflation variance accounted by "global inflation" goes up to 70% in OECD countries). Particularly, developing countries managed to get to levels comparable to developed countries, while developed countries were able to push inflation even lower on average.

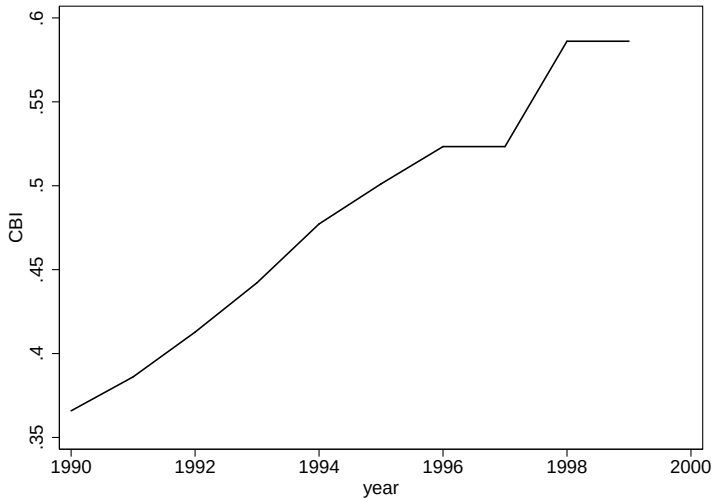
In addition to substantial and general decrease in inflation, variance of inflation among countries dropped as well: even more than the inflation itself. This finding suggests that either low inflation is more stable even in relative terms, that shocks hitting the price level were mild, or that monetary authorities managed to stabilize it.

It is therefore not surprising that inflation targets exhibit strong convergence pattern as well. It is convenient to expect that lowering target implies lower inflation, yet for now we leave the dispute about effectiveness of this process (essential for IT) to others. Our task is to explore the other direction of the implication: how inflation targets are set. For example, rational policymaker would probably set inflation target with past inflation in sight, which suggests a two-way causality between inflation and inflation target. We will examine these thoughts further.

Institutional Development

The fall of inflation itself was accompanied by major developments in institutional characteristics of monetary authorities. The world of central banking has seen a complete

Figure 1.3: Central Bank Independence 1990-2000



Data source: Guillén and Polillo (2005)

turnaround in transparency and communication, central banks got independence in most cases, which created need for some form of accountability to prevent misbehavior. Central banks increased focus on public relations to enhance credibility, which is in turn believed to help achieve the goals of monetary policy.

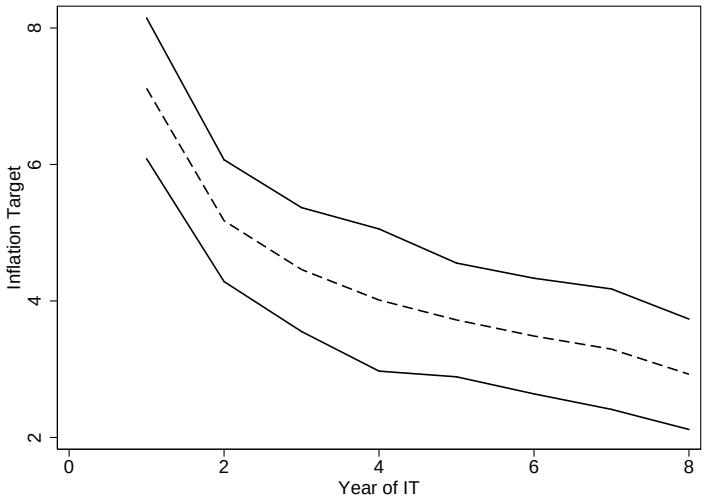
There is not much time-series data on institutional development which would enable us to capture the institutional change. The notable exception is Cukierman's (1992) index of central bank independence (CBI), updated by Guillén and Polillo (2005), who extended it to the whole 1989-2000 period for majority of central banks. We could observe a major increase in the average central bank independence index during 90's, as illustrated in figure.

Converging and Stationary Targets

We have already said that inflation targets exhibited strong convergence, in a way and magnitude similar to inflation itself. However, not all inflation targeting countries started with high targets and ended with low. New Zealand, as a notable example, increased the midpoint of target rate several times, conversely. Several other developed targeters maintained fixed inflation target for the whole period. These are outweighed by disinflating IT countries, both developed and emerging. Substantive decrease in inflation targets therefore remains the overall pattern.

Inflation targeters could be divided (along with Mishkin and Schmidt-Hebbel (2006)) in stationary (those countries which pursue stationary target) and converging (those which adjust targets often to steer inflation towards some optimal rate). Converging inflation targeters generally become stationary after the disinflation and stabilization period, this characteristic evolves over time. It could be argued that the targets are set at the optimal inflation level considering stationary inflation targeters. This is, however, definitely not

Figure 1.4: Mean Inflation Target Trajectory



Data source: Central Banks' web pages, Mishkin and Schmidt-Hebbel (2006)

true for the converging periods.

Table 1.2 shows that while targets in converging IT countries are on average below actual inflation, in stationary IT-ers it is vice-versa. The former probably need lower target to steer inflation down, while the latter are suspicious of target asymmetry. There has been some literature on how and why do central banks consistently undershoot their targets, suggesting that inflation below target is more desired by the central bankers than the same deviation in opposite direction (see for example Buiter and Sibert (2004) discussion of UK case and Smidkova et al. (2008) for the Czech case)

Variance in inflation targets is naturally higher in converging targeters. However, substantial variance in targets chosen is present even among industrialized stationary targeters and our question is: what are the key determinants of observed variability?

Point and Interval Target

Inflation targets take basically two forms: either the bank sets the preferred inflation rate as a point target, or specifies band in which the inflation can fluctuate. The former case means transparent and straight definition of desired inflation, which will be also targeted. It removes public uncertainty about fluctuating inflation in a band. At the same time, it lacks accountability: the inflation will never be at the very target point, so how should we then measure performance of monetary policy? What is the tolerable deviation from the target? What is the implication for central bank governor and board when the target is missed and where is the threshold when we should start to care about it?

These questions are to a large extent solved when interval target is chosen. The fluctuation band is clear, and when it is missed, at least an explanation could be enforced. Reserve Bank of New Zealand goes even further: they fire the governor when he misses

Table 1.2: Inflation and Inflation Target

	All IT's*	Stationary IT's*	Converging IT's*
Mean Inflation	4.05	2.29	6.57
S.D. of Inflation	3.87	1.15	4.76
Mean Inflation Target	3.62	2.34	6.11
S.D. of Inflation Target	2.82	0.80	3.60
Mean Target Width	2.14	2.08	2.27

Data source: Central Banks' web pages, Mishkin and Schmidt-Hebbel (2006), Author's calculations

*only periods of inflation targeting were taken into account

the target without serious exogenous reasons. Accountability could be therefore easily established. The mid-point can play a role of the straight targeted inflation, grabbing the mentioned benefits of simplification when properly communicated.

Therefore it is no surprise that although there were several point targeters in various periods during the two decades of IT, there is only one (Mexico) left nowadays. Others decided to rip the advantages of target band.

Although the point-band dispute seems almost resolved in practice, there is still an open question of the target spread, the width of the band. We do not observe any significant development over time, even in the individual cases. Converging inflation targeters choose a slightly larger spread, as they probably face larger shocks during the disinflaion process.

Still there is some variability in target width even when majority of targeters have yet converged. We will address this issue in the empirical section to get a picture of possible other determinants of inflation target width.

1.2.3 What Do Central Banks Say About Their Targets?

In the introduction we mentioned that central banks often remain silent in case of reasons behind choosing particular inflation target. They simply present the target as their "definition of price stability", like the ECB does[1]. This is for example the case of Poland, Colombia and to some extent also of Bank of England.

[1]ECB announces its 2% inflation target although it is carefully avoiding the word "target" and rather uses the above mentioned "definition of price stability" designation, probably to remind the public that it is *not* doing inflation targeting.

Others, for example Bank of Israel, do not explicitly talk about the inflation target in detail.

The remaining third group provides at least some rationale behind the target rate. Following list presents the most transparent banks considering the inflation targets, together with factors they mention.

Czech National Bank provides relatively extensive explanations of the reasons behind each target. As we have found the Czech National Bank most transparent regarding determinants of inflation targets and moreover the story of inflation targets in Czech Republic is relatively rich, we will devote a separate section to a case study of inflation target decision making in CNB.

Sveriges Riksbank in a press release to the first inflation target in 1993 states "This objective corresponds to the current underlying rate of inflation." (Sweriges Riksbank (1993)) The only determinant presented is thus past inflation. Years after, a more elaborate description of the target appeared at the Riksbank web pages. Similarly to the main arguments of optimal inflation theory, the Riksbank explains the target as a result of trade-off between high volatile inflation: "Too high inflation is harmful to the economy, as inflation usually varies substantially when it is high." and deflationary risks: "But too low inflation is not good either. A too low inflation target increases the risk of deflation, that is, the general price level falls. Deflation has historically been proved to create problems.", also pointing out the CPI bias: "There is a tendency for the CPI to overestimate the actual rate of increase in the general price level. This is because it is difficult to entirely exclude the effects of quality changes in the CPI. To avoid deflation there is thus reason to set the target at a positive figure." (http://www.riksbank.com) Their conclusion is 2% inflation target rate.

Reserve Bank of New Zealand provides some relevant mentions about the reasons behind target setting: "The agreement [about inflation target] is broadly as the markets have been anticipating and is consistent with the publicly stated advice of expert commentators. I expect it to be well-received by the financial markets and by other stakeholders in the economy." Michael Cullen, Minister of Finance.

"The raising of the bottom of the band brings the overall target more in line with New Zealand's inflation outcomes in recent years and those in other countries." Alan Bollard, Governor of Reserve Bank of New Zealand. Both in RBNZ press release in September 2002 (RBNZ02).

The first statement suggests role of inflation target expectations, while the second points out importance of both domestic and foreign inflation.

Bank of Korea is giving satisfactory explanation without saying anything about the particular determinants: "In setting the inflation target itself at the range of $3.0\pm0.5\%$, the Bank aims to reflect the appropriate rate of inflation consistent with Korean economic

fundamentals and to allow itself flexibility in conducting monetary policy to deal with short-term economic fluctuations." But what are the "economic fundamentals" and why is particularly this target consistent with them? We infer that GDP growth and inflation are meant by the statement. The mention about monetary policy flexibility clearly links to the zero nominal interest rate bound which starts to complicate central banker's life in periods of low inflation and deflation. This is probably inspired by the prolonged "Japanese slump" observed in the very neighborhood.

Bank of Thailand is the only central bank explaining the width of the target: "The target band width of 3.5 per cent will help cushion temporary economic shocks and minimize the need for the MPC to adjust monetary policy frequently, thereby reducing short-term interest rate volatility and promoting financial stability."

The above statements found on central banks' web pages start to give some picture about the actual target setting decisions. So far it seems, that central banks ascribe importance to the traditional inflation-deflation trade-off as well as to other factors. Crucial role is played by feasibility of the target, as suggested by mentions about past inflation and "economic fundamentals". This finding confirms the natural assumption: central bankers simply do not want their targets to be missed.

However, as the table shows, by far not every central bank shares the art of inflation target setting with the public. Only 8 of 19 observed inflation targeting banks does publish some determinants of and reasons behind the actual (or past) target. Central bank transparency has surely a long way to go yet.

Although most central bankers do not explain the targets, our survey yields some sensible results. First, as mentioned above, the optimal inflation "Skylla and Charybdys" inflation costs and deflation risks (together with zero interest rate bound aversion) are balanced. At this point, the bias of CPI should be mentioned: as the price level measures often overstate inflation, the targets (in CPI or similar measure)tend to be slightly above the primary suggestion.

Second, feasibility of target fulfillment is taken into account, putting weight on past inflation and development in real economy.

Third, other factors of "appropriateness" are admitted: both foreign and expected inflation and targets. These factors seem to be valid mainly in small open economies. Clearly, a policymaker should care about foreign developments more when the share of exports and imports account for a large portion of GDP.

But is this the end of the story? Are these few published determinants the only variables the banks care about while setting their inflation targets? Our suggestion is, that central banks take into account a bit broader set of indicators than they openly admit. For example, we miss any institutional factors like credibility and independence, the two

Table 1.3: What Do Central Banks Say About Their Inflation Targets?

	Explain Target?	Determinants Mentioned
Australia	YES	Costs of Inflation
Brazil	NO	
Canada	YES	Costs of Inflation, Measurement Error, Wage Rigidities, Zero Interest Rate Bound
Chile	NO	
Colombia	NO	
Czech Republic	YES	Past Inflation, Inflation Expectations, Long-Term Target, Foreign Target, Price Convergence, Wage Rigidities, Zero Interest Rate Bound, Measurement Error
Finland	NO	
Israel	NO	
Mexico	NO	
New Zealand	YES	Past Inflation, Foreign Inflation, Target Expectations
Peru	NO	
Poland	NO	
South Africa	NO	
South Korea	YES	Past Inflation, Economic Fundamentals, Monetary Policy Flexibility
Spain	NO	
Sweden	YES	Past Inflation, Costs of Inflation, Risks of Deflation, Measurement Error
Switzerland	YES	Measurement Error
Thailand	YES	Foreign Inflation
United Kingdom	NO	
	$\sum$ 8/19	

Source: Central banks' web pages

buzzwords of modern central banking. It is, however, reasonable that central bankers do not openly admit these as determinants of their targets.

1.2.4 Case Study: Inflation Targets of the Czech National Bank

In the Czech Republic inflation targeting was adopted by the start of 1998, i.e. 9 years after New Zealand had pioneered the practice. The decision to switch monetary policy regime to inflation targeting was born in a turmoil of CZK currency crisis, when the crawling peg regime of exchange rate targeting must have been abandoned. The Czech National Bank had to seek another nominal anchor, another intermediate target for monetary policy. It was decided to adopt inflation targeting, mainly due to the apparent success of the framework in countries which have been already practicing it. However, Czech Republic was the first transitional emerging market market economy to adopt IT, so there were substantial uncertainties involved. For example, there was only a shallow understanding of transmission mechanism, short time series to learn from and elaborate forecasting system had yet to be developed.

The Czech National Bank entered inflation targeting in 1998 with 3.5-4.5% inflation target (denominated in net inflation, which excludes regulated prices and effects of indirect taxes) to be met by the end of 2000. In addition, a short-term target was defined to anchor the expectations of the convergence path: 5.5-6.5% short-term inflation target band to be met by the end of 1998. For the end of 1999, the short-term target band was lowered to 4-5%.

In 1999, a Monetary Strategy Document was published, where a long-term target of 1-3% in net inflation was set to be met by the end of 2005. Reducing inflation differential

between Czech Republic and the most important trade partner, the Eurozone, is stressed in this document, further motivated by the Maastricht accession criteria. However, there was a long way to go in convergence of both regulated and non-regulated prices so the inflation target was not set immediately at the "definition of price stability" of the ECB: "The long-term inflation target must be consistent with the strategy for our integration into European institutions, and above all with the demands of EU and EMU accession" and "the rate of progress towards price and monetary stability and the anticipated time horizon for achieving this must take into account necessary structural adaptations, particularly the adjustment of relative prices." (CNB (1999))

For the end of 2001, an inflation target band was set at 2-4%, still in net inflation. Past inflation development, inflation expectations and "general macroeconomic environment" (probably meaning also the real economic activity) were mentioned as crucial determinants: "The inflation target for 2001 reflects the low inflation level achieved so far and expresses the monetary policy intention to maintain this low level in the next period. The target level is in line with the predictions for inflation factors in 2001 and conforms with the inflation expectations of economic agents. The forecasts also indicate that this inflation target is consistent with the expected favourable characteristics of the Czech macroeconomic environment." (CNB (2000))

An extraordinary form of inflation target was chosen for the period 2002-2005. The CNB switched to headline inflation (as share of regulated prices decreased) and set a gradually declining target band from 3-5% to 2-4%. Accordance to the previously set Monetary Strategy is stressed throughout the document. An addition, a space for price convergence towards the Eurozone is mentioned as a reason for higher inflation target: "The suggested headline inflation target is in line with the CNB Monetary Strategy. ... The proposed trajectory for the inflation target can meanwhile be expected to leave sufficient room for price adjustment in connection with EU convergence." (CNB (2001))

From January 2006, CNB is targeting headline inflation at 3% with 1% tolerance band. Apart from the above mentioned target determinants, statistical overvaluation, wage rigidity and zero nominal interest rate bound are explicitly mentioned as factors taken into account: "The inflation target ... also conforms to the limitations stemming from statistical overvaluation in measuring inflation. The target takes into account also the zero nominal interest rate bound and the potential downward inflexibility of wages." The target has been set 1% above the ECB target upper bound: "This small inflation differential reflects the long-term real convergence of the Czech economy towards the euro area average." (CNB (2004))

Finally, for beyond 2010, the inflation target is set to 2% with 1% tolerance band. The determinants mentioned are the same as in previous cases. Still, the argumentation is led along the line of convergence (which is, however, almost over) and is related to the Eurozone. The target is set at the ECB "price stability definition" upper bound, as "the need to keep open a positive inflation differential as one of the channels for raising the Czech price level to the level of the advanced countries will gradually subside." (CNB (2007))

1.3 Model

In the following theoretical section we will set up a simple theoretical model to put some structure to our central question "How do central banks set their inflation targets?". The IT research considered the inflation target as an exogenous variable so far. To address our question we will have to make inflation target endogenous and derive the optimal target or target path from minimization of central bank loss function and a few structural equations.

To the best of our knowledge, there has been no attempt to endogenize inflation targets yet. Several papers were devoted to optimal inflation (as discussed in the previous section) and we will use the results in our model. A few studies examined the optimal disinflation process (Mahadeva and Smídková (2001), for example) but no paper has yet simulated inflation target setting process.

1.3.1 Methodology

We will start with a simple Svensson-type (Svensson (1998)) backward-looking model, which treats inflation target exclusively as exogenous. We will continue with incorporating changes which will allow us to endogenize the target. Several simulations will follow. In the simulations, we will primarily focus on the disinflation process: we will set initial inflation to 30% and observe the convergence path.

An optimal path of inflation target will be computed in the simulations as well. We will observe a central bankers' optimal target-setting decisions during disinflation process. What we are primarily interested in are the determinants of particular target choices. We will perturb parameters of the model to see the implication for inflation target level and path. The implied relationships will be then tested in the empirical section.

We will also discuss how alternative treatment of expectations will affect the model. Static, rational and target-adaptive expectations will be considered and we will observe implications for target-setting behavior in simulations.

Although this model describes target setting behavior mainly during disinflation using political economy of monetary policy, it constitutes a simple framework for analysis of decision making about inflation targets. In the long term our model converges to the long term target, the rate implied by the theory of optimal inflation. However, our framework could still provide valuable insight in what factors may influence the target (and in which direction), in addition to those suggested by optimal inflation theory.

1.3.2 Basic Model

Svensson's Model

The departure model for our framework is Svensson's (1998)) "simple closed-economy backward-looking model". The model consists of aggregate supply equation (Philips curve):

$$\pi_{t+1} = \pi_t + \rho y_t + \varepsilon_{t+1}$$

where π_t is inflation in year t, y_t is an output gap and ε_t is a cost-push shock with zero mean and constant variance σ_ε^2. The inflation responds to output gap with one year lag and expectations are static, fully backward-looking. The Phillips curve also constitutes one-year ahead inflation forecast.

Next element of the basic model is the aggregate demand (IS curve):

$$y_{t+1} = \alpha y_t + \beta z_t - \gamma(i_t - \pi_{t+1|t} - \bar{r}) + \eta_{t+1}$$

where α and β are assumed positive, i_t is nominal interest rate (monetary policy control instrument), $\pi_{t+1|t}$ is inflation forecast for period $t+1$ in period t, $\bar{r}$ is average real interest rate and η_t is t's demand shock with zero mean and variance σ_η^2. z_t is an exogenous variable following an AR(1) process:

$$z_{t+1} = \delta z_t + \theta_{t+1}$$

where δ is assumed positive and θ_t is shock with zero mean and variance σ_θ^2. Finally, the central bank loss function is:

$$L = \frac{1}{2}[(\pi_t - \pi^T)^2 + \lambda y_t^2]$$

where both λ is supposed to be positive. The loss function represents what Svensson calls *flexible inflation targeting*. This kind of central bank is not one of the "inflation nutters", but cares to some extent also about stabilizing output (and unemployment) fluctuations.

Our Modification

For our purposes we make a few changes in the very beginning. First, we do not need the IS curve at all. IS curve links the CB control variable, nominal interest rate, with the output gap. For now it is sufficient to suppose that output gap could be controlled by the CB (via interest rate and IS curve) and treat output gap directly as control variable. Doing this we also drop Svensson's AR(1) exogenous demand shock variable.

Second, we use a more convenient form of Phillips curve. In our setting the influence between inflation and output gap takes place in one period, leaving space also for vice-versa impact of inflation on output gap (and unemployment). We see this form as more suitable than the "one-way" relationship used by Svensson. Our basic form is also a static-expectation simplification of the standard New Keynesian Phillips Curve as referred for example by Walsh (2007 and 2008) and many others.

Our basic model takes following simple form:

$$L = a(\pi_t - \pi^T)^2 + cy_t^2$$

$$\pi_t = \pi_{t-1} + \rho y_t + \varepsilon_t$$

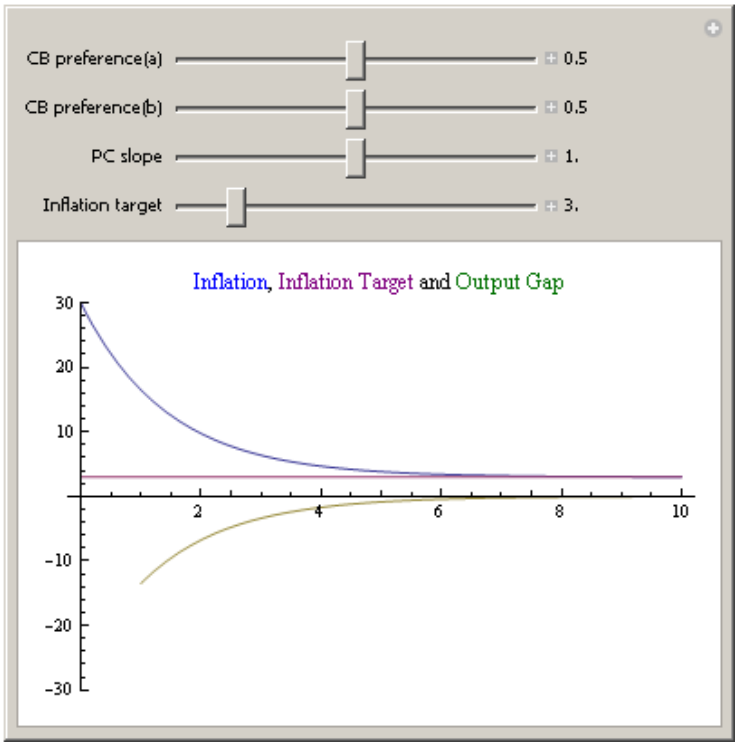
First order conditions for inflation and output imply (assuming that ε_t is IID with zero mean)

$$\pi_t = \frac{-a\pi^T\rho^2 - c\pi_{t-1}}{c + a\rho^2}$$

$$y_t = \frac{\rho a(\pi^T - \pi_{t-1})}{c + a\rho^2}$$

These two recurrence equations fully describe the system. Solving them we get the optimal paths of inflation and output gap, while infaltion target being still exogenous. In the simulations we focus on the disinflation process: we set initial inflation to 30% and observe convergence towards equilibrium.

Figure 1.5: Disinflation in the Basic Model with Exogenous Target



Initial inflation 30%. Other parameters set on sliders with the exact values on the right.

Results of first simulations could be seen in the figure. With 30% initial inflation, equal central bank preferences between inflation deviation and output gap, Phillips curve with slope $\rho = 1$ and exogenous target set at 3% the inflation converges close to the target only after about 6 years.

Increasing CB preference weight on deviation of target relatively to output gap speeds up the disinflation and so does higher ρ (sensitivity of inflation to output gap). Although the target is exogneous here, we have laid the basic framework for introducing the target as another control variable of central bank.

1.3.3 Making the Inflation Target Endogenous

To succesfully depart from classic Svensson's framework and endogenize the inflation target we need a few modifications to the basic equations.

Broader Central Bank Preference

First and most importantly, we make use of conclusion from the preceding section: inflation target does not generally equal optimal inflation. As we have observed, this is the case mainly of converging targeters, who clearly want to steer inflation down from high levels by gradually lowering the target. But even in case of static targeters, often traditional developed countries, the situation is not all that clear, even as the central banks themselves admit.

In Sweden, for example, inflation target choice is backed by argument of past inflation, which has little to do with the optimal inflation theory. That way we would get to a self-fulfilling circle: optimal inflation would be determined by past inflation, which would then as a target influence present inflation. We could then explain any level of inflation as optimal, which is surely not the case. Inflation targets do not always equal optimal inflation.

Realizing this we might think of broader preferences of central banks: not even that they care about output gap and deviation of inflation from target, but they also do not want the inflation to depart from its optimal level, which is not generally equal to the target. It might be as well viewed form the other side: central banks cares about output gap and deviation from the optimal level of inflation, but moreover they do not want their targets to be missed. This might be for several reasons:

- Credibility building: it is simply not convenient if the CB misses the target. It damages credibility of monetary policy conduct, of IT framework, of the target itself and of the whole institution. Moreover, losing credibility would lead to loose control over inflation expectations in the future and thus further damage effectiveness of monetary policy.

- Professional reputation: the bank board (or MPC) members are independent agents maximizing their own utilities. They are also economists with professional credit and reputation and fulfilling the target brightens their public image. This effect might be even strengthened by peer-pressure among central bankers.

- Optimal contracts: as suggested by Walsh (1995), contract with the governor and the board could be set directly contingent on fulfillment of the target. For example, as was the case of the Reserve Bank of New Zealand, the governor could be fired for missing the target without exogenous reasons. Far more common are contracts at least forcing governors to send open letter explaining why the target has not been met. These practices surely strengthen CB leaders' dedication to the target, but will also influence the target setting. The bank board would choose more conservative and easier achievable goals to exploit the "optimal" contract.

These arguments together with apparent disparity between targets and "optimal inflation" rates leads us to propose an alternative central bank preference.

On the basis of preceding discussion, we propose following general loss function of a CB:

$$L(\pi_t, y_t) = a(\pi_t - \pi^\star)^2 + b(\pi_t - \pi_t^T)^2 + cy_t^2$$

where $\pi^\star$ is the optimal inflation for the country, π_t^T is the inflation target for time t, y_t and π_t is t's output gap and inflation, respectively. a, b and c are positive weights of central bank relative preference between the loss items.

Phillips Curve

Next, we further tune up the Phillips curve to capture a favorable effect of inflation targeting: anchoring inflation expectations. As we have mentioned in the introduction, most academic commentators agree that inflation targeting reached one notable success among others: inflation expectations of the public are well anchored close to the target in almost all IT countries (Mishkin (2004), Mishkin and Schmidt-Hebbel (2001, 2006), Walsh (2007, 2008) and others).

We thus propose a simple New Keynesian Phillips curve in a form

$$\pi_t = \pi_{t|t-1}^E + \rho y_t + \varepsilon_t$$

where expectations are treated as target-adaptive

$$\pi_{t|t-1}^E = \kappa\pi_t^T + (1-\kappa)\pi_{t-1}$$

with the coefficient κ being a measure of central bank target credibility. In this specification, inflation in period t is determined by t's output gap and inflation expectations for period t. These expectations are assumed to be weighted average of inflation target (anchored expectations) and lagged inflation (imperfect credibility of the target). This framework thus allows for some degree of inflation persistence.

In this model y_t and π_t^T are control variables, the tools of monetary policy. π_t^T is a direct tool, as central bank or other monetary authority (for example the target for Bank of England is set by Britain's Chancellor of Exchequer) sets it directly. y_t is managed via interest rate and its effect on aggregate demand (captured by the IS curve), which we exclude from the model and treat y_t as a control.

Static expectations Let's now consider alternative specification of the Phillips curve, namely alternative treatment of inflation expectations. First, we will elaborate the idea of simple static expectations, as presented in the simple model in Svensson (1998). If the expected inflation was equal to the lagged value, the Phillips curve would take following form:

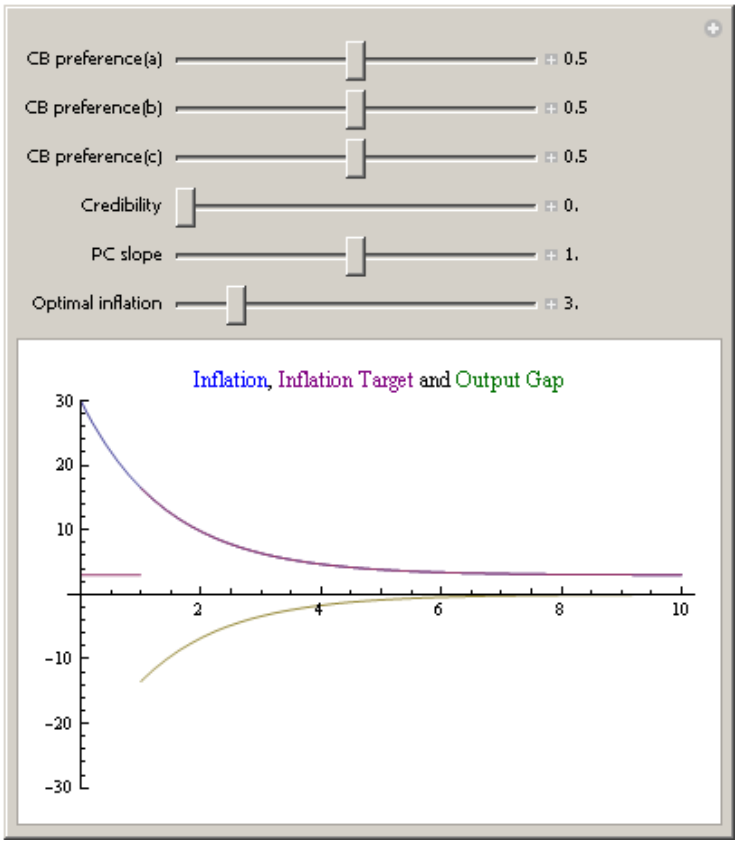
$$\pi_t = \pi_{t-1} + \rho y_t + \varepsilon_t$$

Which means that inflation target has no effect on inflation expectations and could only serve as the "equilibrium point", as optimum in the central bankers' loss function. In

this case the central bank does not effect inflation in other way than via the interest rate-aggregate demand management. No anchoring of inflation expectations takes place, which contradicts the observed reality and empirical evidence from a number of surveys discussed above. In such a model the monetary policy maker would lose maybe the most powerful feature of inflation targeting framework.

No need to show the computation steps for this simple case here, see further sections and Appendix for the technical details. Instead we could realize that whenever the a element of the CB's loss function is nonzero and positive and the target does not appear in the constraining Phillips curve, central bank would not want to deviate inflation from the target at all. Simply said, CB does not help the situation by setting another target than inflation which it expects for the next period, as it has no effect in the Phillips curve, no steering of inflation expectations takes place. As a result, the optimal target path copies the inflation trajectory (in our simple model without price level shocks).

Figure 1.6: Disinflation in the Model with Endogenous Target: Static Expectations



Initial inflation 30%. Other parameters set on sliders with the exact values on the right.

Although this setting might sound unrealistic, trajectories of such behavior were commonly observed in disinflation periods of converging inflationary targeters. Anyway, we incorporate this option in our main model by leaving the credibility parameter κ to take any value in the $[0, 1]$ interval. The static expectations case is the case of $\kappa = 0$. Following

the logic of the model, this might be the reason for similar behavior observed in disinflating targeters: the CB's might not have had enough credibility to use target to manage and steer inflation expectations, but still had the target and moreover wanted to gain credibility. It was then rational to set the target to be fulfilled in the next period and to gain credibility (and professional reputation) for not missing it.

Rational expectations Maybe the most convenient way how to treat inflation expectations would be to consider them fully rational. However, also this approach has important drawbacks, as we will show.

The rational expectation version of the Phillips curve takes following form:

$$\pi_t = \pi^E_{t|t-1} + \rho y_t + \varepsilon_t$$

where $\pi^E_{t|t-1}$ is a rational expectation, i.e. expectation set by rational agents with knowledge of the model. In other words, the price- and wage-setters captured by the Phillips curve know how the central bank would react to any inflation they may expect. Central bank knows about their knowledge, which is again known to the agents and so on. Technically, one has to compute the best-response function of the central bank conditional on the expected inflation, derive the expression for expectation and plug back in the Phillips curve.

In this ideal world of rational inflation expectations the sacrifice ratio (integral of output gap to the inflation gap) is zero. As the agents fully foresee central bank's reactions, the central bank knows this as well and sets the target directly at the level of optimal inflation. The target is fulfilled without any need for active monetary policy shocks to interest rate, and thus with no output gap at all.

These results, although favorable for the economy and central bank, are far from what is observed in reality and contradict the empirical findings. There were substantial and prolonged disinflation periods, during which inflation targets were gradually adjusted downwards on yearly basis. Realizing this, we opt for the target-adaptive inflation expectations, which best captures the observed behavior of inflation and inflation targets. Our Phillips curve form also leaves space for impact of central bank credibility for anchoring inflation expectations.

1.3.4 Model of Endogenous Inflation Target Under Imperfect Credibility

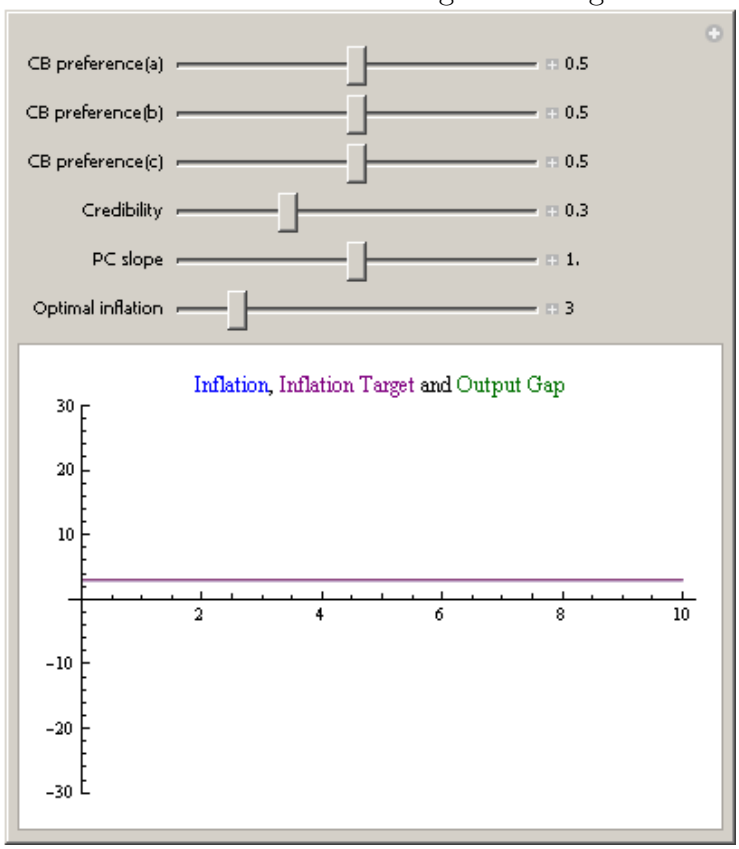
Now we get back to our inflation targeting model:

$$L(\pi_t, y_t) = a(\pi_t - \pi^\star)^2 + b(\pi_t - \pi^T_t)^2 + cy^2_t$$

$$\pi_t = \kappa\pi^T_t + (1-\kappa)\pi_{t-1} + \rho y_t + \varepsilon_t$$

In this expectations form, some of the price- and wage- setters believe that the inflation target will be fulfilled and adjust prices according to the target for the present period, but

Figure 1.7: Disinflation in the Model with Endogenous Target: Rational Expectations



Initial inflation 30%. Other parameters set on sliders with the exact values on the right.

others do not fully believe the targeting regime and their expectations are rather static: they increase prices by the rate of last year inflation. Mixture of these two extremes is also allowed and the aggregate proportion of target credibility is captured by the parameter κ. This relation between expectations and credibility is used for example by Bomfirm and Rudebush (2000).

By allowing for variability in κ, this setting best captures the observed data: imperfect credibility in emerging market economies (see for example Fraga, Goldfajn, Minella (2003)), but at the same time apparent anchoring of inflation expectations when the credibility is gained.

Other charactestics of the model are same as above. According to the standard New Keynesian Phillips Curve output gap influences inflation and vice-versa in the same period (see Galí and Gertler (1999) for thorough discussion and structural derivation). Central bank cares not only about output gap and deviation from inflation target, but also about deviation from optimal inflation (also referred as long-term target or "definition of price stability"), as inflation targets do not always equal the country-specific optimal inflation.

The first order conditions lead to:

$$\pi_t = \frac{\pi^\star(b(c\kappa^2 + a\rho^2)) + \pi_{t-1}(ac(1-cr)^2))}{ac(1-\kappa)^2 + b(c\kappa^2 + b\rho^2))}$$

$$\pi_t^T = \frac{\pi^\star(b(c\kappa^2 + a\rho^2)) + \pi_{t-1}(c(a(1-\kappa)^2 - b\kappa(1-\kappa)))}{ac(1-\kappa)^2 + b(c\kappa^2 + b\rho^2))}$$

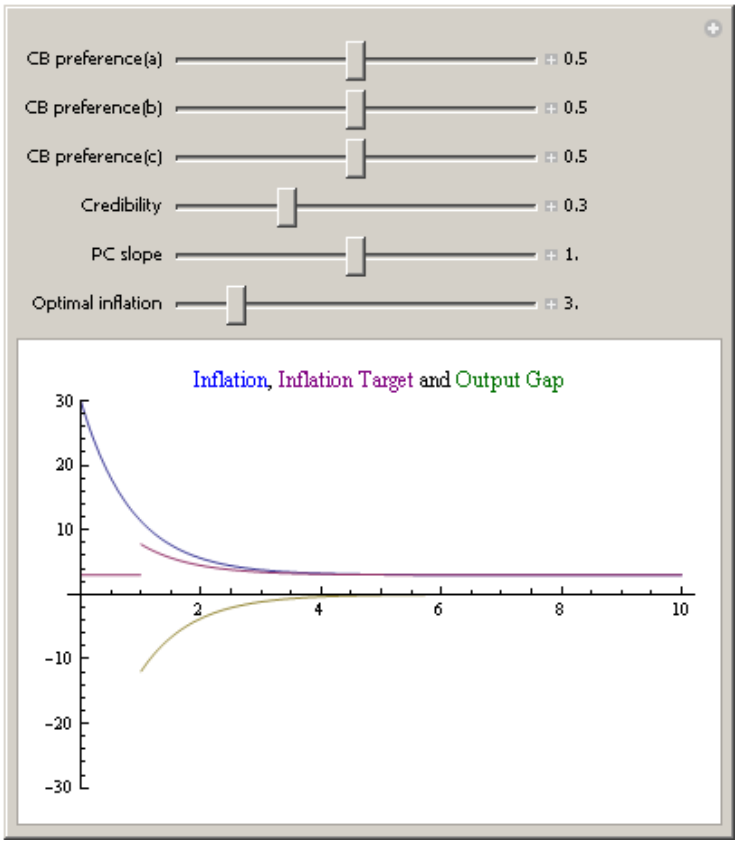
$$y_t = \frac{\pi^\star(ab\rho(1-\kappa)) - \pi_{t-1}(ab(1-\kappa))}{ac(1-\kappa)^2 + b(c\kappa^2 + b\rho^2))}$$

which is a system of difference equations describing dynamic behavior of the variables of interest.

Simulation Results

The simulation of disinflation process following a high-inflation period with initial $\pi = 30$ is presented in the figure.

Figure 1.8: Disinflation in the Model with Endogenous Target With Imperfect Credibility



Initial inflation 30%. Other parameters set on sliders with the exact values on the right.

The model implies about 3 years disinflation period with the parameters used in previous cases. Compared to the static expectations case, where the IT regime fails to manage

expected inflation, the disinflation period is of about half length. The initial drop in output gap is of similar magnitude and the negative effect lasts shorter with the disinflation period. This result is driven by ability of inflation targeting regime to drive inflation expectations which directly enter the Phillips curve. The expectations are controlled by announcing the inflation target. Central bank therefore gets another tool in addition to the output gap control via interest rate and the IS curve. As the parameters of the loss function are in this particular simulation equal, the additional tool of managing inflation expectations via the inflation target allows the central bank to achieve significant reduction in both length and total cost of disinflation.

As could be seen from the figures, the target for next period is being set below the actual inflation to steer inflation expectations towards the long term target. And opposite, the target is set above the long term target (optimal inflation), because deviation from the target is costly for the central bank. But how do other parameters influence the targeted inflation rate in the disinflation model?

Credibility An alternative scenario with credibility parameter $\kappa = 0.5$ is presented in the Figure 1.9b. Under given set of parameters (the basic case is in Figure 1.9a), increased credibility leads to shorter disinflation period with less total costs in output. Our variable of interest, inflation target, is lower with higher credibility. As price- and wage-setters start to believe central bank that it is capable of and willing to meet the target, they will set prices closer to the target. Central bank can thus choose target closer to the desired rate of optimal inflation.

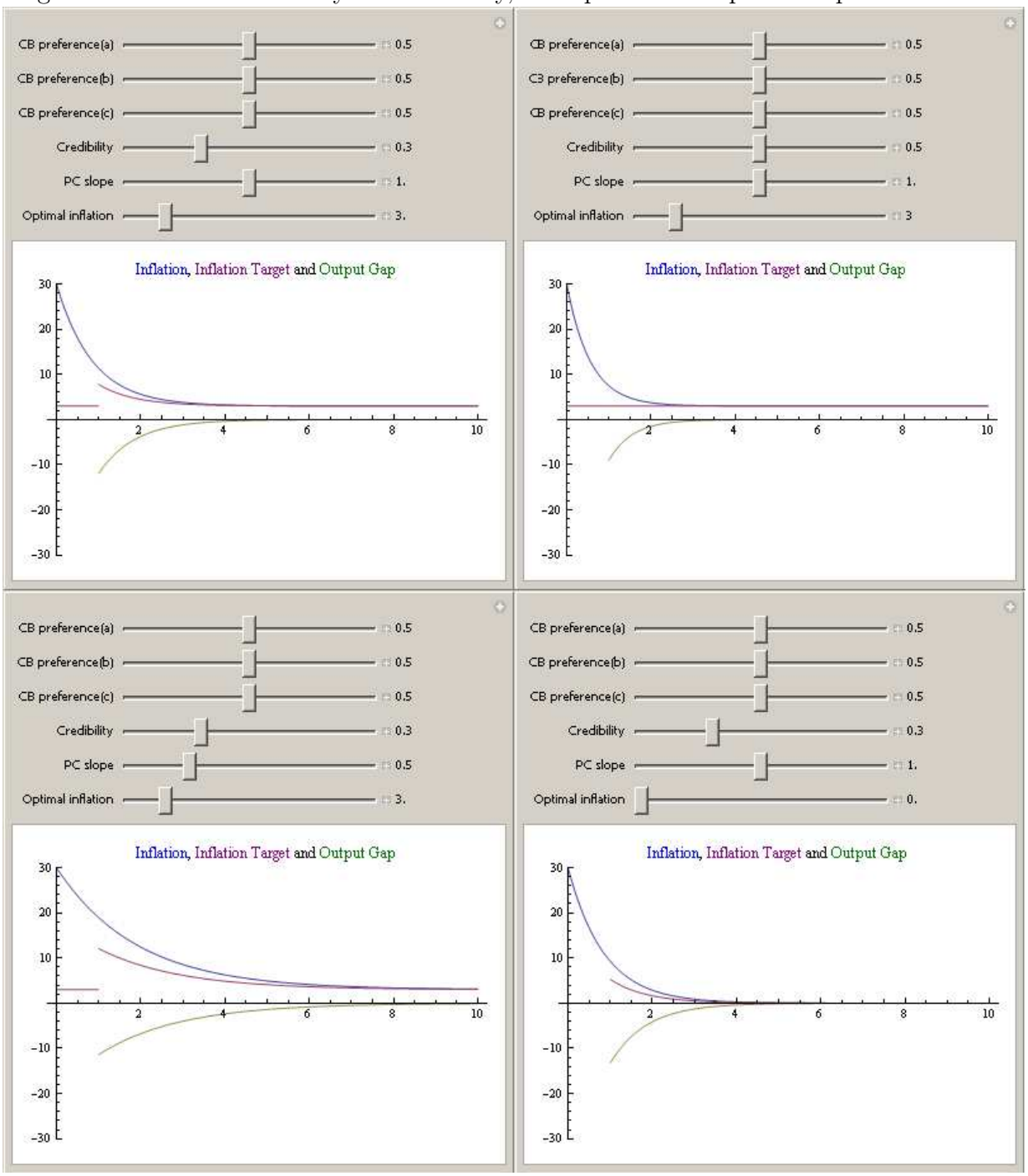
In this theoretical framework, central bank chooses target even below the level of optimal inflation if credibility is too high. The reason is simple: by setting target slightly below optimal rate, inflation jumps immediately close to the true optimum, resulting in low costs of inflation deviating from either short term target or optimum. However, we consider this extreme solution not very realistic. No such fine-tuning was actually observed among inflation targeting central banks.

Although we primarily focus on disinflation here, this setting theoretically holds also for the less frequently observed reverse case, in pushing the price level dynamics from deflation to positive inflation. Here, maybe, similar overshooting can occur. Central bank would desperately need to shift public inflation expectations to positive rates. CB could adopt inflation targeting with the target set higher than long-term optimal inflation, just because large break in public expectations is needed.

Slope of Phillips Curve Slope of Phillips curve describes how much inflation responds to the output gap. The steeper Phillips curve, the more inflation reacts to changes in output. Slope of Phillips curve thus also marks the efficiency border of monetary policy. When the prices do not respond enough, monetary policy has tied hands because shifts in aggregate demand via changes in interest rate do not influence the price level enough.

In our case, shown in Figure 1.9c, slope of Phillips curve is negatively related to the speed of disinflation, which is implication of the above arguments. Steeper Phillips curve

Figure 1.9: Model Sensitivity to Credibility, Phillips Curve Slope and Optimal Inflation



Initial inflation 30%. Other parameters set on sliders with the exact values on the right.

gives monetary authority more power over price level, so the desired long term inflation target is more easily reached in shorter period of disinflation.

As the price level responds more to changes in output and interest rate, central bank could aim at inflation rates closer to the long term optimum. Consequently also inflation target tends to be lower (in the disinflation process) with steeper Phillips curve.

Optimal Inflation Change in long term inflation target naturally affects also short term target. In our model, the long term target is an equilibrium point towards which both inflation and short term inflation target converge. If the optimal inflation is raised by an amount, the convergence gap is smaller. Central bank consequently starts to care more about deviation of inflation from target. As a result, inflation target is higher in absolute terms.

Central Bank Preference Central bankers' preference over the elements of the loss function is also an important determinant of the model economy behavior. Particularly we are interested in weights which central bank puts on output gap, deviation of inflation from target and deviation from the optimal inflation.

The effects of various settings of central bank preference weights can be seen in Figure 1.10. The first simulation refers to the basic case, where the preference weights are uniform for the three elements of the loss function.

Figure 1.10b shows the case where the central bank weights more deviation from the inflation target than the other loss elements. We could interpret this as a proxy for central bank independence: independent inflation targeting central bank does care about it's contract, which is primarily (in the RBNZ case even solely) price stability defined by the target. We could then infer that more independent central bank would put more weight on deviation of inflation from target compared to the other two elements of the loss function.

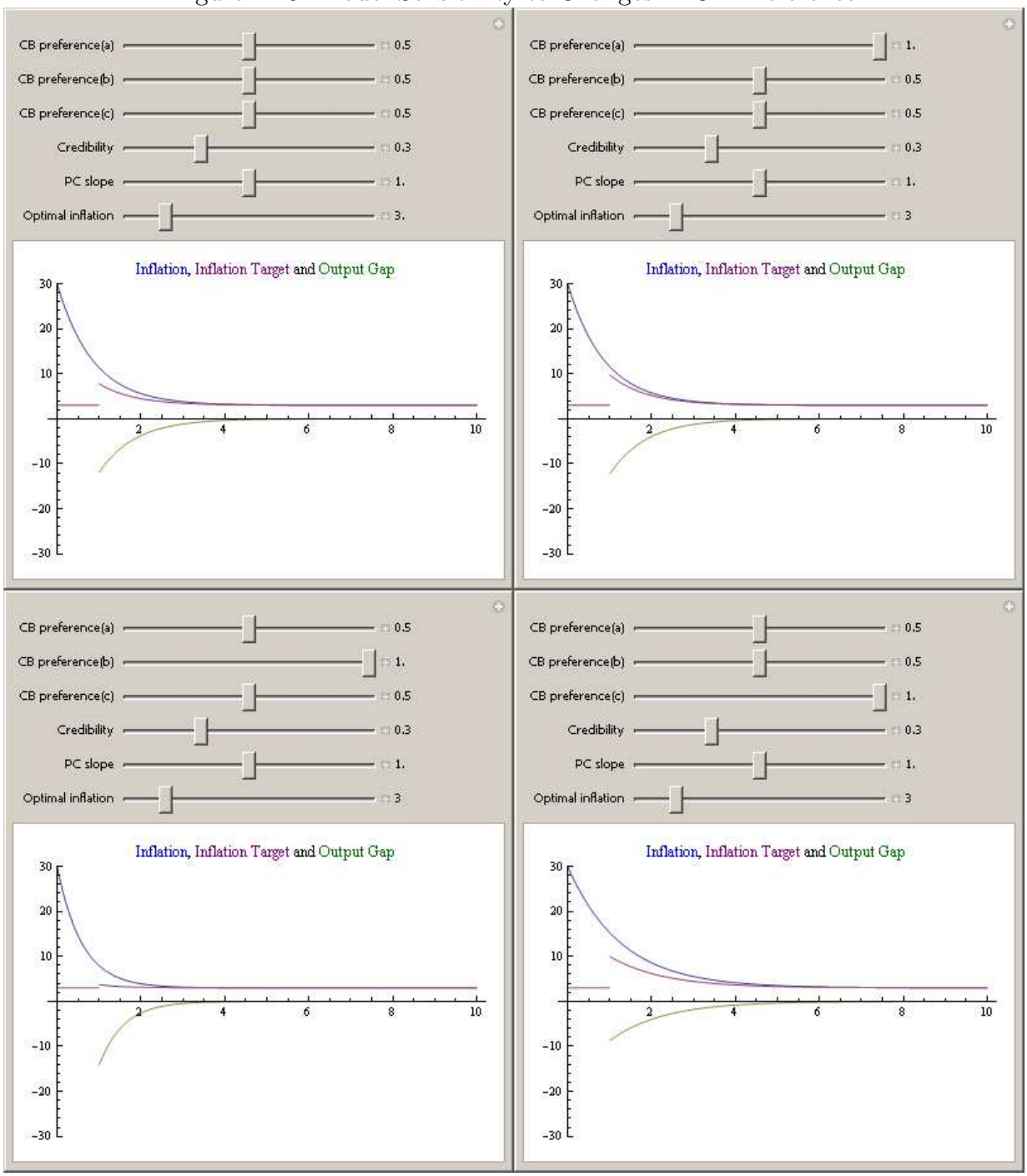
Increasing the "a" weight on deviation from inflation target leads to the target chosen closer to the inflation path. In the disinflation case the inflation target is therefore set higher. Central bank simply does not want to deviate from it and looks less at the speed of disinflation and development of output gap. Quite surprisingly, higher target independence leads to higher inflation target in our model framework, contrary to the common belief that more independence leads to lower inflation.

The third section of Figure 1.10 shows how the system behaves when more weight is put on deviation from long-term target (optimal inflation). This would be probably the case of non-targeting central banks with only implicit targets, which they are not obliged to fulfill. It could also describe well some weak inflation targeting regimes, where the target is not communicated strongly, example could be Israel.

Increasing importance of inflation gap from the "definition of price stability" leads to more aggressive policy during disinflation, the central bank needs to steer inflation down as soon as possible. Consequently, the target is lower to speed up the process.

The last element of central bank loss function is output gap. The change of relative preference weight on output gap is shown in the last section of Figure 1.10. High importance

Figure 1.10: Model Sensitivity to Changes in CB Preference



Initial inflation 30%. Other parameters set on sliders with the exact values on the right.

of output gap for the central bank could be related either with lack of independence or broader mission of the central bank set by law of particular country.

When the output gap aversion is high, the central bank chooses slower disinflation path to minimize large swings in economic activity. As a result, also inflation target is closer to the actual inflation and therefore higher.

1.3.5 Model Conclusions

We have developed a simple model of central bank policymaking, where the inflation target is endogenous. To the best of our knowledge, this is the first attempt to endogenize inflation target itself and to discuss possible inflation target determinants and their effects. Our framework is useful mainly for analysing target setting behavior of central bank during the disinflation process. However, the model sets a basic framework for further discussion. Moreover, some of the identified effects could have broader validity beyond the period of disinflation.

First, it is clear that inflation target depends on past inflation and, in the same manner, on the initial inflation from which the economy is disinflating. As the central bank's optimum is valid for every period separately same as for the whole disinflation path, it is virtually not important from where is the economy starting. One could think about the system as of a Markov chain. When explaining current state, it does not depend on any other state than the previous one. As a result, from rate of inflation $\pi = 30$ the system is converging the same way if it started directly in $\pi = 30$ or if the starting inflation was much higher and the economy has been already disinflating for several years. So, inflation target is positively related to past inflation.

Next, it is definitely related to credibility of central bank. The higher credibility, the lower target central bank could credibly set and really fulfill in the next period.

Inflation target is also related to slope of Phillips curve. The stronger is the transmission channel from interest rate via aggregate demand to inflation, the lower inflation target could be chosen. For both cases, increase in credibility or Phillips curve slope leads to lower target and shorter disinflation period.

The choice of short- or medium-term inflation target is clearly related to the long-term target, the country-specific optimal inflation or "defintion of price stability" as sometimes called. Determinants of the optimal inflation are suggested by the theory of optimal inflation (surveyed for example by Billi and Kahn (2008)).

Optimal inflation balances the trade-off between traditional costs of inflation and deflationary risks. From this we could infer that past inflation variance could be an indicator of optimal inflation for particular country, because a measure of inflation volatility also proxies the risk of falling in negative numbers of price level development.

Last but not least, inflation target definitely depends on central bank preference. More particularly, on the preference weights which the central bank puts on the elements of the loss function.

If the central bank extraordinarily cares about deviation from target, the target will be higher, as it will be costly to miss it.

In case importance is given to deviation from long-term optimal inflation, the inflation target will be lower to speed up the convergence to desired levels.

And in case of central bank which puts lot of weight on smoothing output gap relative to the inflation control, the inflation target will be high and the disinflation rather gradual than shock-type, as no large swings in output are desired.

In the next section we will test these theoretical findings in an empirical analysis.

1.4 Empirics

In the first section we have surveyed inflation-targeting central banks to find what determinants they admit to take into account while deciding about particular level of inflation targets. Having found that by far not every central bank is willing to share its practice of inflation target setting and that even some of the most transparent and communicative central banks list only a few variables, we have developed an endogenous-target model to asses the question theoretically. Now we are about to test the findings from previous sections on the observed data.

This section is another important innovation of this thesis: there hes been, to the best of our knowledge, no empirical survey of determinants of inflation targets carried out so far.

1.4.1 The Data

We use panel data of 19 inflation targeting countries, the same sample as used in Mishkin and Schmidt-Hebbel (2001). However, we extend the time series until 2008. There has been quite a few more central banks adopting inflation targeting since then, but we stick with the traditional sample used in the paper cited above.

The cross-country dimension of the dataset is characterized by variability between developed inflation targeters (UK, Sweden, Australia, New Zealand, Switzerland,...) and emerging market economies (Chile, Colombia, Brazil, Czech Republic, Poland,...). In the middle of these extreme cases are mid-developed countries (Israel, South Africa, South Korea...). While the first ones adopted inflation targeting in relatively calm periods, only solving the need for stabilizing prices with strong nominal anchor, the latter ones switched to the regime in pretty rush times. Latin-American countries were just out of hyper-inflationary periods and wanted to maintain bearable inflation rates. For example both Brazil and Peru experienced four-digit year-on-year inflation just three years before adopting IT. Colombia experienced prolonged period of two digit inflation. In Central European countries the transformation process was clearly not yet over, large share of prices still regulated by the government, currency crises in flare. The variance of starting positions was large. However, we would still like to find some common principles how the central banks chose their inflation targets.

We use yearly data. Higher frequency is not needed, as inflation targets are set at most on the yearly basis. Target adjustments with higher frequency than once a year was

not observed in the sample. Our time series ranges from 1987 to 2008, yet the number of observation is limited by the year of adoption of inflation targeting in particular countries (and, in case of Finland and Spain, the date of entering the Eurozone). Inflation targeting was pioneered by Royal Bank of New Zealand in 1989. We observe two preceding years to be able to incorporate lags and past volatilities in the analysis.

Figure 1.11: Converging and Stationary Targeters

As was already written in the introduction, the global overall trend during the observed period was decline in inflation rates, which was definitely not only case of inflation targeting countries. However, this trend is reflected in our data: many IT countries (all emerging economies and also lot of developed countries) started inflation targeting by process of disinflation. During this period inflation targets were gradually decreased until inflation reached long-term desired levels. According to Mishkin and Schmidt-Hebbel (2006) we call these "converging targeters", while the other group with targets already at the long-term levels is called "stationary targeters". Targeters which have inflation target stable for more than three years we call stationary. Therefore it is common for a "converging targeter" to become stationary after convergence period. Upwards movement of the target is not considered as convergence, but more likely as fine-tuning (this is, for example, case of RBNZ, which increased target twice by 0.5%: in 1997 and again in 2003).

Fundamentals

When we are interested in determinants of inflation targets we have to start with basic macroeconomic variables, describing the overall state of the economy.

As a main measure for inflation we use year-on-year change in CPI. For comparison and

robustness checks we employ also GDP deflator. The developments of price level during the observed period were discussed in the introductory section.

We use price level measured by PPP to test hypothesis of price convergence: do countries with low price levels set high inflation targets to speed up the price convergence towards (developed) countries where prices are already high?

As a measure for inflation volatility (being of utmost importance in debate over optimal inflation) we use sample variance of past inflation records. Statistics including past 5 and 10 observations are computed. As we expect that policymakers who decide over inflation targets value more recent developments, we make average of sample variances in past 5 and 10 years.

$$wvar_t = \frac{1}{2}\sum_{i=t-5}^{t}\frac{(\pi_t - \overline{\pi})^2}{5} + \frac{1}{2}\sum_{i=t-10}^{t}\frac{(\pi_t - \overline{\pi})^2}{10}$$

In the resulting statistic more weight is put on the recent 5 years than on the previous ones. Design of the measure of past inflation volatility is arbitrary to a large extent, so we use simple 10 year sample variance as an alternative and a robustness check.

We also use an indicator of world CPI inflation. Although we did not include this open-economy feature in the theoretical model, some central banks are openly admitting inflation of their trade partners and world inflation as a determinant of inflation target.

The data were provided by SourceOECD (CPI inflation), Federal Reserve Bank of Cleveland (world CPI inflation) and Penn World Table (PPP-measured price level).

As a measure of real economic activity we conventionally use GDP per capita. However, we are more interested in the short- and medium- fluctuations than in absolute levels. We use GDP per capita growth, which is the main indicator published by the statistical offices and is heavily used in monetary policy communication. As our survey focuses primarily on central bank communication (inflation target being the most important part of it) we do not stick with the filtered output gap measures, which have much less intuitive explanation and are less frequently used in communication with the public.

Institutional Characteristics

In addition to economic fundamentals we use softer institutional characteristics which may influence the decision process and value of inflation targets.

As shown in the model, credibility of central bank is crucial when forming inflation expectations. Using information about central bank credibility (and about inflation expectations) while deciding about inflation target might be a reasonable strategy. However, there are no time series data on credibility available. We use cross sectional index of central bank credibility developed by Cecchetti and Krause (2002). The credibility index has no time-series dimension, so it will only be used to explain cross-country variation.

Second buzzword of modern central banking, independence, could also have effect on inflation target choices. Will the more independent central banks set lower targets due to more inflation-hawkish preferences or will they choose more conservative and feasible values to exploit their contracts and increase professional reputation by easily hitting the targets?

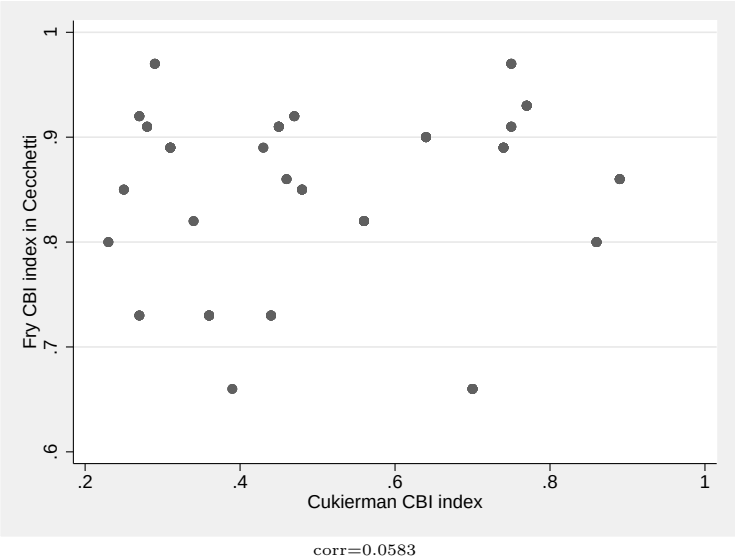
The prime choice while measuring central bank independence is Cukierman (1992) CBI index, which is composite measure based on both legal and real indicators, such as correlation of governors' term in office with the political cycle. We use data from Guillén and Polillo (2005), who extended the Cukierman CBI index up to 2000. The rest of the sample up to 2008 was extrapolated using the last observation in each country.

For comparison we use index of central bank independence presented in Cecchetti and Krause (2002), originally developed by Fry et al. (2002). Fry uses questionnaire, where he asks central bankers questions about their independence, aiming to find out

1. how important is inflation in the CB objective,
2. how much does central bank influence the setting of inflation target (goal independence),
3. how much does central bank control instruments of monetary policy (instrument independence),
4. if the government does rely on central bank financing,
5. governor turnover frequency.

This survey-based approach has been, however, subject to some critique. Central bankers would probably provide biased answers to make impression of high independence. We have compared the two indices (see the Figure 1.12) and found striking results: there seems to be no correlation among the two.

Figure 1.12: CBI Indices



The correlation index of Fry's and Cukierman's CBI indices is below 6%. This finding seriously undermines reliability of independence indices. However, we still have decided to

Table 1.4: Summary statistics: Inflation Targets

	Mean IT	IT Development	Mean IT Width	Mean Inflation(IT period only)
Australia	2.50	0	1.00	2.61
Brazil	4.90	-3.5	4.30	7.91
Canada	2.25	-2.0	2.00	2.11
Chile	6.07	-14.5	2.33	7.23
Colombia	6.75	-11.0	1.00	7.50
Czech Republic	3.68	-3.0	1.82	3.49
Finland	2.00	0	0.00	1.23
Israel	5.47	-12.5	1.93	6.12
Mexico	4.85	-9.5	1.75	7.24
New Zealand	1.84	-2.0	2.32	2.15
Peru	5.60	-15.5	1.93	6.60
Poland	4.08	-4.7	1.86	4.46
South Africa	4.50	0	3.00	5.14
South Korea	3.50	-6.0	1.55	3.41
Spain	2.75	-1.75	0.50	2.45
Sweden	2.00	0	2.00	1.10
Switzerland	1.00	0	2.00	0.96
Thailand	1.75	0	3.50	2.16
United Kingdom	2.35	-0.5	2.44	2.63
Avg	3.57	-4.55	1.96	4.03

use Cukierman index in our survey, mainly because it is more frequently cited and used in the literature. Moreover, the Fry et al. (2002) index is subject to the mentioned critique of survey-based indices. We keep this ambiguity in mind while interpreting the results.

Government Party As a last indicator we use use record of government party orientation. The data are taken from the WDI database. The variable takes following values: -1 for left wing (UK labor, US democratic), 0 for center and other orientation, 1 for right wing (UK conservative, US republican).

If the government party orientation would prove to have significant effects on inflation target choices, this would shine a new light on the central banks independence fever: although many of the inflation targeting central banks declare themselves to be independent, such relationship would suggest the contrary. However, it may also reflect the practice of some leading inflation targeting countries, namely United Kingdom and New Zealand, where instrumental independence is carefully guarded but the goals (inflation targets) are set by ministers of finance.

Inflation Target We move a bit deeper in analysis of the explained variable. Summary statistics focused on individual countries are presented in the Table 1.4. The most important observation is the weak decrease in inflation targets: none of the countries has higher inflation target compared to the date of IT adoption. This confirms the general view of decline in both inflation and targets over the observed period and also justifies our focus on disinflation process in the theoretical section.

1.4.2 Model Specification

We want to estimate the equation explaining inflation target determinants. However, inflation target is rarely just a single point. More often inflation targeting policymakers choose a target band, as illustrated in the introductory section. With respect to this observation, we use Random Effects Interval Panel regression for our purpose. However, to provide robustness checks, we compute target central point and use it for alternative estimators. We compare the results of interval regression (which we believe is most appropriate in this case) with simple pooled OLS, with Random Effects GLS and finally with Fixed Effects estimator. In the last case the estimated fixed effects are collinear with the time-invariant credibility index. To solve this, we drop the credibility index from Fixed Effects estimates, which, moreover, serve only as robustness check.

The model takes general form

$$[\pi_{i,t}^{T(L)}, \pi_{i,t}^{T(U)}] = \beta \mathbf{X}_{i,t-1} + \varepsilon_{i,t-1}$$

where $\pi_{i,t}^{T(L)}$ and $\pi_{i,t}^{T(U)}$ inflation target upper and lower bound (respectively) in country i and time t. $\mathbf{X}_{i,t-1}$ is a vector of explanatory variables in country i and time $t-1$.

Note that we are using one year lagged explanatory variables. The reason is that inflation targets are principally decided one year ahead, target is set for the next year. We realize that in stationary countries policymakers probably do not annually decide that they keep the target at a same level. However, if the decision is taken, the data observed and used in the target setting process are no less than one year lagged behind the nominal target validity.

β is a vector of estimated parameters of the model and $\varepsilon_{i,t}$ is a residual.

1.4.3 Basic Model

We start with the final model of inflation targets with all inflation targeters included. The best model is presented in the first column. In the next columns, significance tests of other variables are performed. In the last column, another measure of past inflation volatility (sample variance of last 10 observations) is included to test robustness of our main inflation volatility measure.

The empirical model to a large extent confirms the results of the theoretical model of previous section. Although the theoretical section is based on a closed-economy model, in the empirical part we add element of world inflation, motivated by the fact that central banks often mention foreign inflation developments as a factor they take into account. Estimated coefficients accord with the findings suggested by the presented central bank optimization model and, moreover, all variables are statistically significant on the 10% significance level.

Table 1.5: Determinants of Inflation Targets: Parameter Significance Tests

	(1)	(2)	(3)	(4)	(5)
CPI Inflation	0.495***	0.493***	0.500***	0.489***	0.510***
	(15.75)	(14.47)	(15.64)	(15.12)	(16.96)
Inflation Volatility[1]	0.439**	0.440***	0.450**	0.457***	
	(2.51)	(2.43)	(2.54)	(2.60)	
Credibility	-0.516**	-0.534*	-0.441	-0.576**	-0.440*
	(-2.22)	(-1.77)	(-1.56)	(-2.26)	(-1.92)
GDP Growth	0.150***	0.155***	0.155***	0.144***	0.158***
	(3.93)	(3.76)	(4.00)	(3.73)	(4.45)
World Inflation	0.124**	0.114*	0.115**	0.128**	0.0253
	(2.15)	(1.77)	(1.96)	(2.22)	(1.40)
PPP Price Level		-0.000724			
		(-0.17)			
Independence			0.099		
			(0.18)		
Government Orientation				-0.0674	
				(-0.67)	
Inflation Volatility[1] (b)					0.248***
					(2.93)
Intercept	0.617*	0.75*	0.558	0.652**	1.01***
	(1.92)	(1.85)	(1.09)	(2.00)	(4.37)
N	130	114	123	130	134
AIC	202.6	191.1	202.8	204.0	210.6
BIC	225.5	215.7	228.1	229.8	233.8

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[1] premultiplied by 10^{-6}

Past inflation has positive effect on inflation target, as expected. It is reasonable to expect that inflation target choice heavily depends on past inflation: when it has been high, policymakers will likely set high target and gradually disinflate. When it has been low, there is no reason to set high targets.

Higher credibility delivers lower inflation target. This is in line with our previous theory-based suggestion. Credible central bank can set lower inflation target during the disinflation. Due to the fact that majority of inflation targeting central banks went trough disinflation period during the inflation targeting era, this effect is captured in the data. Another reason might be the self-confidence of credible central banks, which dare to set very low targets close to zero because the anchoring of inflation expectations is solid and therefore the risk of deflation is low. Both these effects contribute to the observed relationship: high credibility implies low inflation targets.

Inflation volatility has a positive effect on inflation target. This is also not surprising and in line with our theoretical findings. Inflation volatility is a crucial determinant of optimal inflation, as it determines the risks of hitting zero nominal interest rate bound and

falling into deflation. On the other hand, optimal inflation is determined by costs of high inflation. These are, however, not easily measurable and it can be supposed that here is not much cross-country variance in this respect. As a result, inflation volatility remains as the main measurable proxy for optimal inflation. Realizing the empirical finding that higher past inflation volatility implies higher targets, we could link this with the positive relation of optimal inflation and inflation target from the theoretical section.

GDP growth, our measure of real economic activity and proxy for output gap, seems to have positive effect on inflation target. Although this relationship does not have straight counterpart in our theoretical model, it some intuition behind could be found.

First, the causality link could follow the Philips curve: high output gap (proxied by GDP growth) leads to high inflation, which is related to high inflation targets. However, we have already controlled for inflation in this regression, so this effect should be mitigated.

Second, high GDP growth is often related to high openness of emerging market economies. If we could link growth with openness (as many authors do, the topic is surveyed by Baldwin (2003)), there exists empirical evidence of flattening Phillips curves (see Kuttner and Robinson (2009)) caused by economic globalization. Open economies are surely influenced most by these effects: their price levels depend much more on foreign development, inflation is imported in most cases. Therefore domestic output gap has lower effect on domestic prices (which are to a large extent linked with foreign prices), the Phillips curve gets flatter. The whole story is that high GDP growth is linked with lower slope of Phillips curve. And here we get back to our theoretical model, where we have shown that inflation target is higher with flatter Phillips curve. This is, in the end, the same finding that is suggested here by the empirics.

World inflation appears to have expected positive impact on inflation target, as inflation targeting countries are often open and want to have inflation harmonized with their trade partners. Moreover, factors like convergence towards "strong developed neighbor" (e.g. the Eurozone, as illustrated in the CNB case) might play important role in the target setting process.

Other variables are not statistically significant. We can not directly compare information criteria between the models because of differences in number of observations. We could infer that Schwarz-Bayes and Akaike information critera in the model with the price level are low precisely because low N. The second-best in terms of BIC and AIC is our first model.

Because of the interval panel regression estimator, we have not many measures of fit for the estimated model. R^2 is not defined in this case. However, we can asses the problem by running Random Effects GLS panel regression on inflation target central point and compare results and information criteria (which are also available for the interval panel regression). We will present alternative estimators in the next section.

1.4.4 Alternative Estimators

We continue by checking robustness of our preferred model by applying alternative estimators: to the Random Effects Interval Panel regression we add simple pooled OLS,

Table 1.6: Determinants of Inflation Targets: Alternative Estimators

	(1) Interval RE	(2) Pooled OLS	(3) Random Effects	(4) Fixed Effects
CPI Inflation	0.495***	0.478***	0.470***	0.453***
	(15.75)	(15.98)	(15.19)	(12.99)
Inflation Volatility[1]	0.439**	0.453**	0.469**	0.502**
	(2.51)	(2.57)	(2.50)	(2.31)
Credibility	-0.516**	-0.701***	-0.754***	
	(-2.22)	(-3.24)	(-2.78)	
GDP Growth	0.150***	0.144***	0.142***	0.141***
	(3.93)	(4.12)	(4.06)	(3.80)
World Inflation	0.124**	0.147***	0.156***	0.187***
	(2.15)	(2.65)	(2.83)	(3.11)
Intercept	0.617*	0.644**	0.646**	0.186
	(1.92)	(2.08)	(2.01)	(0.61)
N	130	130	130	130
R^2	.	0.807	0.807	0.786
AIC	202.6	333.4	.	305.9
BIC	225.5	350.6	.	320.3

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[1] premultiplied by 10^{-6}

simple Random Effects estimator and Fixed Effects with excluded credibility (because the time-invariance causing collinearity with the fixed effects).

The alternative estimators provide favorable results. Our basic model seems to be consistent and robust to alternative estimation techniques. All parameters are again significant and all of them in the same direction as in the basic interval regression model.

Important is that now we have R^2 at least for the alternative models. As the information criteria are comparable (the interval regression model scoring even better), we infer that the R^2 for our model could be around 80%, which is more than satisfactory.

From the theoretical point of view and the logic behind the model we suggest use of Interval Random Effects GLS estimator. Fixed effects is not appropriate because of the nature of the problem: when we estimate fixed effects for every country, we would immediately get rid of the country-specific element. We would lose the variance among inflation targeters, which we are primarily concerned about. Still, there are some technical conditions for random effects and these issues have also to be tackled.

Use of Random Effects estimator supposes that the country-specific part of the error term is uncorrelated with the explanatory vector of variables $\mathbf{X}$. Recall the general model specification

$$[\pi_{i,t}^{T(L)}, \pi_{i,t}^{T(U)}] = \beta \mathbf{X}_{i,t-1} + \varepsilon_{i,t-1}$$

and suppose that

$$\varepsilon_{i,t} = u_i + e_{i,t}$$

where both u_i and $e_{i,t}$ are i.i.d. with zero mean and constant variance. The u_i term, moreover, has to be orthogonal to the individual effects. This could be tested by Breusch-Pagan Lagrange Multiplier test for Random Effects. When we test the model with simple Random Effects on central point of inflation target, the p-value for the test is 0.37, and therefore we do not reject the null hypothesis and it is appropriate to use Random Effects.

Further, we test the significance of Fixed Effects: we use F test for joint significance of individual fixed effects. The p-value for the test is 0.19 and therefore we do not reject the null hypothesis that u_i are jointly zero. Again, this gives support to use of Random Effects.

Finally, we perform Hausman test for Random Effects, which is based on presumption that both Fixed Effects (OLS with dummy variables for all countries) and Random Effects GLS are consistent under the null hypothesis (uncorrelatedness of u_i and the regressors, i.e. orthogonality of random effects), while only Fixed Effects OLS is consistent under alternative (u_i and X correlated). The p-value for the test statistic is 0.94, i.e. we do not reject orthogonality of random effects and the Random Effects GLS estimator is appropriate.

We have therefore a strong support for using Random Effects. The tests are not available for the interval panel regression. However, as it uses the same Random Effects GLS estimator and the fixed effects are insignificant, we justify our use of Interval Random Effects GLS estimation technique. Still, even the alternative methods confirms the findings of the above presented main model.

1.4.5 Stationary Targeters

The model of inflation target determinants give fairly strong and robust results which accord with the theoretical section when all inflation targeters are included in the maximum available periods when inflation targeting was practiced. It might be interesting to look how the results change when we depart from the whole sample and cut the converging disinflators.

It is reasonable to expect that arguments and results from the theoretical sections may not hold while focusing on the stationary targeters. On the other hand, we may get a clean view of determinants which influence inflation target values when no disturbing convergence is in place. We might explain the lasting long-term variance among stationary targets. Why do central banks consistently optimize with consistent, but different results?

The findings are a bit less unanimous and less clear compared to the previous case when all the targeters were pooled together in one model. Still we can find some interesting results. However, in the sample of stationary targeters and the models presented in the table, the Breusch-Pagan test for Random Effects rejects the null hypothesis of random effects orthogonality and Fixed Effects would be recommended. Also the F test for joint significance of u_i as estimated parameters does reject the hypothesis that the fixed effects are jointly zero.

However, there is no option of Interval Fixed Effects. Moreover, Fixed Effects OLS estimator does not fit our purpose due to loss of country-specific variance which we precisely want to explain here. And finally, the results of the tests might be biased (asymptotic

Table 1.7: Determinants of Inflation Targets: Stationary Targeters

	(1) Interval RE	(2) Pooled OLS	(3) Random Effects	(4) Fixed Effects
CPI Inflation	0.0188**	0.205***	0.0101	-0.00208
	(2.38)	(4.06)	(0.50)	(-0.15)
Inflation Volatility	-0.000577	-0.00116	-0.000819	0.00041
	(-0.50)	(-0.22)	(-0.16)	(0.07)
Credibility	-0.802***	-0.316	-0.881***	
	(-10.89)	(-0.94)	(-2.63)	
GDP Growth	-0.0134***	0.0767*	0.0117	0.00461
	(-2.75)	(1.95)	(0.71)	(0.40)
World Inflation	0.0065	0.0614	0.00361	-0.0059
	(1.18)	(1.32)	(0.19)	(-0.42)
PPP Price Level	-0.00392***	-0.0120***	-0.00526**	-0.00118
	(-6.33)	(-3.06)	(-2.38)	(-0.71)
Independence	-0.481***	-0.046	-0.607**	-0.295
	(-13.0)	(-0.12)	(-2.18)	(-1.36)
Government Orientation	-0.0558***	-0.116*	-0.0717*	-0.0516*
	(-6.54)	(-1.68)	(-1.77)	(-1.74)
Intercept	3.47***	2.64***	3.59***	2.62***
	(51.59)	(5.11)	(10.15)	(11.47)
N	78	78	78	78
R^2	.	0.663	0.469	0.162
AIC	-28.0	123.6	.	-118.5
BIC	-3.1	144.8	.	-99.6

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

conditions for validity of Hausman test do not hold), as the intra-country time variance is very low in stationary targeters. By estimating an almost time-invariant inflation target by Fixed Effects we would get the stationary target itself as the fixed effect and significance of other parameters will be low. And this is precisely what could be seen in the regression output.

To sum up, we stick to the Interval Random Effects again. This method will capture the cross-country variance as well as the interval nature of inflation target. However, we should keep in mind limitations coming from the above discussion.

As we depart from borders linked by the theoretical section, we include all relevant explanatory variables to the model, observe the empirical relationships and provide the intuition later. Surprisingly, all parameters included to the Interval Random Effects model are significant.

The effect of past inflation is positive, as expected. In countries with tradition of low-inflationary environment also the inflation targets tend to be low, here is nothing to wonder about.

Inflation volatility is not significant determinant of inflation targets in stationary tar-

geters. This might be caused by the fact that inflation volatility is generally lower in countries with stationary target and the effect on the level of targeted inflation is more difficult to distinguish.

Central bank credibility has again a significant negative impact on inflation target. When talking about stationary targeters, we use similar logic as in the previous case. Credibility helps the central bank to effectively control inflation expectations and subsequently inflation itself. Consequently, it does not have to worry so much about inflation falling too low. As the costs of high inflation are similar and deflationary risks decrease with higher credibility, inflation target can be set lower.

Effect of GDP growth is the only one ambiguous in the subsample of stationary targeters. The negative sign in Interval RE model is contradicted by the simple pooled OLS result. Moreover, we see no clear intuition how could GDP growth influence inflation target when this is stationary. This might be caused by effect of an unobserved variable (a successful economic reform, for example), which implies that high GDP growth and low inflation target are commonly observed together.

Negative relation of targets with price level points out significance of price convergence. Countries with lower price levels converge to countries with higher price levels as implied by interest rate parity relationship. One of the means of price convergence is inflation. It is straightforward that when price level is low, central bank would target higher inflation to help the price to converge. However, why did this effect not appear earlier, in the basic model? Probably because disinflating central banks do not care much about price convergence and are primarily focused on steering down inflation. Such fine-tuning emerges as significant first in the stationary targeters' subsample.

Negative sign of the independence parameter links to the inflation averse independent central banker suggested by Rogoff (1985) as a solution for time-inconsistency problem. It could be so that the more independent an inflation targeting central bank is, the more it is focused on the quest for price stability and chooses lower targets.

What is interesting is the significance of government party orientation. Left-wing governments imply higher inflation targets. This is in line with the common view that left-wing governments prefer higher public spending (and therefore are more likely to impose inflationary taxation), documented for example by Pettersson-Lidbom (2008) on Swedish data. But more importantly, it poses some questions about central bank independence. It seems that while central banks got instrument independence in most cases, the question of goal independence is still open. Inflation targets are significantly influenced by party orientation of government in charge. It might also be an effect of countries where the inflation target is set directly by government (New Zealand and Great Britain).

1.4.6 Converging Targeters

Now we switch our focus to the other subsample of inflation targeting countries, to the converging targeters. There is considerably low number of observations in the converging targeters sample.

Breusch-Pagan test p-value of 0.23 suggests that even on the 10% siginficance level we

can not reject hypothesis that random effects are orthogonal. Hausman test scores p-value of 0.48, we do not reject consistence of Random Effects GLS estimator. Moreover, F test for joint significance point out that on the 10% significance level (with p-value 0.49) we cannot reject joint hypothesis that fixed effects u_i equal zero.

All these tests suggest that Random Effects GLS estimator is appropriate and superior to Fixed Effects. We use, however, Interval Random Effects for the reasons mentioned in above cases.

Table 1.8: Determinants of Inflation Targets: Converging Targeters

	(1) Interval RE	(2) Pooled OLS	(3) Random Effects	(4) Fixed Effects
CPI Inflation	0.557***	0.564***	0.564***	0.618***
	(5.20)	(4.41)	(4.41)	(4.03)
Inflation Volatility[1]	0.516*	0.529	0.529	0.433
	(1.87)	(1.50)	(1.50)	(0.82)
Credibility	0.880	1.04	1.04	
	(0.57)	(0.56)	(0.56)	
GDP Growth	0.192***	0.195**	0.195**	0.140
	(2.63)	(2.17)	(2.17)	(1.41)
World Inflation	-0.199	-0.209	-0.209	-0.407
	(-0.69)	(-0.60)	(-0.60)	(-0.82)
PPP Price Level	0.0100	0.0155	0.0155	0.0913
	(0.78)	(0.95)	(0.95)	(1.51)
Independence	-0.658	0.194	0.194	
	(-0.23)	(0.06)	(0.06)	
Government Orientation	0.144	0.189	0.189	-0.311
	(0.33)	(0.37)	(0.37)	(-0.50)
Intercept	1.96	0.992	0.992	-2.69
	(0.88)	(0.36)	(0.36)	(-0.68)
N	31	31	31	31
R^2	.	0.791	0.791	0.614
AIC	96.9	117.1	.	106.3
BIC	112.6	130.0	.	116.4

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[1] premultiplied by 10^{-6}

In the converging subsample model we get far less variables significant. Further, model results have to be taken with some degree of reservation due to the low number of observations. A bit surprising is also the fact that Random Effects estimator and simple pooled OLS give identical results. This may be caused by time-invariance of some included variables (credibility and independence).

The overall impression is that as for stationary targeters almost all listed variables matter, mainly the soft institutional ones, for converging targeters only the hard fundamental economic measures have significant impact on inflation targets. Our basic empirical model

gives strong, robust results for the whole group, while if we distinguish between stationary and converging targeters, more institutional variables matter for the stationary subgroup but only fundamental measures influence decision in converging disinflators.

The main and most significant determinant of inflation targets in converging group is past inflation. This is intuitive and we have shown in the theoretical section why. Past inflation is starting point for re-optimization which takes place every period (also for shocks to be taken into account). It is clear that the first thing the disinflating policymakers would look at would be the inflation itself. The higher is past inflation, the higher target will be chosen.

Next significant parameter is GDP growth. The higher GDP growth, the higher inflation targets tend to be. Although we do not find a straight transmission link between these two variables, we could realize that low GDP growth is related to negative output gap, which could signal that central bank chose rapid disinflationary path and also the inflation targets would be thus set lower. However, this is again an effect of a third unobserved variable (chosen speed of disinflation and aggregate demand management by the central bank).

Finally, the last variable which is significant to some extent is past inflation volatility. The effect goes in the supposed direction: higher volatility delivers higher targets, as implied by the theory of optimal inflation (higher volatility increases risks of deflation).

Although significance of parameters is generally not as high as in the previous case, available measures of fit (especially R.E. GLS $R^2 = 0.79$) point that the model provides reasonable explanation of the variance in the data. Still, we should be aware of low number of observations.

1.4.7 Target Band Width

Finally, we estimate empirical model for target band width. We use again the whole sample of all inflation targeters. In this case we have no background of theoretical model and we rely on intuition while explaining the results. Developing more elaborate theoretical model of inflation target setting, which includes also target band width is one of the possible venues for further research.

In this case we repeat the story form stationary subgroup model of inflation targets. Breusch-Pagan test rejects the hypothesis of random effects orthogonality (p-value 0.00), as well as Hausman test (p-value again 0.00). Fixed effects are jointly significant (p-value 0.00). However, as we have discussed above, we are interested in the Random Effects estimator, not in the Fixed Effects OLS, which would most likely estimate the target band width itself as a fixed effect.

We stick with the Random Effects GLS estimator, keeping the test results in mind. Also the measure of fit for the Random Effects model is very low, which further weakens the model reliability.

In the Random Effects model the only significant variable is past inflation volatility. This is most reasonable: the higher the inflation volatility, the wider target band will be chosen by the central bank to overcome the negative effects on credibility if inflation target

Table 1.9: Determinants of Inflation Target Band Width

	(1) Pooled OLS	(2) Random Effects	(3) Fixed Effects
CPI Inflation	-0.0286	0.0156	0.0340
	(-1.30)	(0.77)	(1.65)
Inflation Volatility[1]	-0.158	-0.225*	-0.281**
	(-1.29)	(-1.90)	(-2.32)
Credibility	-0.543**	-0.149	
	(-2.02)	(-0.40)	
GDP Growth	-0.0340	0.00227	0.0116
	(-1.25)	(0.10)	(0.55)
PPP Price Level	-0.000954	0.000366	0.00446
	(-0.34)	(0.10)	(0.91)
Independence	-0.808*	-0.320	0.181
	(-1.98)	(-0.59)	(0.24)
Government Orientation	-0.295***	-0.0455	0.0779
	(-3.74)	(-0.51)	(0.80)
Intercept	2.868***	2.120***	1.368**
	(8.18)	(4.39)	(2.02)
N	90	90	90
R^2	0.221	0.111	0.000
AIC	161.4	.	82.9
BIC	181.4	.	100.4

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[1] premultiplied by 10^{-6}
(we exclude world inflation)

was missed. However, there is surely a trade-off in the width of target band, otherwise every central bank would choose large bands. Too loose target, on the other hand, would probably not be as efficient in anchoring inflation expectations as narrow target. Still, the empirical evidence confirms the intuitive argument that high inflation volatility moves the optimum of the trade-off towards wider targets.

1.5 Conclusion

We have tried to asses how do central banks set their inflation targets.

We have surveyed inflation targeting central banks' web pages to find out how they explain choices of particular targets. Despite the common emphasis inflation targeting central banks put on transparency and communication, only a minority of them bother with communicating the determinants of their inflation targets and factors they mainly take into account. Among the economic variables mentioned by the several banks which are willing to share their target-setting know-how appear: past inflation, foreign inflation, expectations, measurement error of inflation measures. Target is sometimes explained to balance risks of deflation (and of hitting zero nominal interest rate bound, which makes

monetary policy impotent) and costs inflation. In New Keynesian theory these are for example menu costs, shoe-leather costs, costs of re-optimization. This is also consistent with suggestions of optimal inflation theory.

Still, it is a minority of inflation targeting central banks who do not stay silent in this respect and reveal the "secrets of the temple".

We have presented a theoretical framework to deal with our basic question. Our framework is based on Svensson's simple IT model and is useful mainly for the case of explaining inflation targets during disinflation periods. The results and simulations show, that inflation targets are sensitive to the initial level of inflation, to the long-term target suggested by optimal inflation theory, to credibility of central bank and of the IT regime (the higher credibility, the lower target), to slope of Phillips curve (the steeper PC, the lower target) and finally to central bank preference weights in the loss function.

We have continued with empirical section, trying to estimate inflation target determinants using interval panel regressions on the panel dataset of inflation targeting countries. The main model with all inflation targeters included confirms findings of the theoretical section to a large extent. Past inflation is significant determinant with expected positive sign. Past inflation volatility, which links to the deflationary risks-inflationary costs tradeoff in the optimal inflation theory, proves to have significant positive effect on inflation target as suggested by the theoretical section. Index of central bank credibility has significant negative effect on the target: the more credible central bank is, the lower targets it dares to set. Significant positive effect of GDP growth might be linked with the slope of Phillips curve via openness of the economy.

We have then divided the sample into two subgroups: stationary and converging targeters. Stationary targeters have shown larger dependence on soft institutional variables: to significant negative effect of credibility we added negative effect of independence and government party orientation (left-wing governments imply higher targets), both significant. This may reflect the fact that some inflation targeting central banks are not goal-independent and the targets are set by governments (Bank of England and Royal bank of New Zealand, for example). Converging targeters then show dependence only on hard economic measures: GDP growth, past inflation and inflation volatility.

Inflation targets are, however, not just a simple points nowadays. Most central banks set inflation target band to allow for fluctuations caused by minor price level shocks and to enhance monetary policy flexibility. We have made an attempt to explain variance in inflation target width empirically. The main significant determinant of inflation target width is past inflation volatility, the higher volatility, the broader target band width.

We have made a first step in explaining how do central banks set their inflation targets and presented both theoretical and empirical analysis of the problem. Still more research is definitely needed on the discussed topics to check robustness of our findings.

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Appendix: Mathematica Code of the Model

Lagrange function and differentiation:

```
LU[pi_[t_], pit_[t_], ygap_[t_], pie_, a_, b_, c_, lm_[t_], cr_,
  st_] := a (pi[t] - pit[t])^2 + b (pi[t] - pie)^2 + c (ygap[t])^2 +
  lm[t] (pi[t] - (cr (pit[t]) + (1 - cr) pi[t - 1] + st (ygap[t])))

D[LU[pi[t], pit[t], ygap[t], pie, a, b, c, lm[t], cr, st], ygap[t]]
=>
-st lm[t] + 2 c ygap[t]

D[LU[pi[t], pit[t], ygap[t], pie, a, b, c, lm[t], cr, st], pit[t]]
=>
-cr lm[t] - 2 a (pi[t] - pit[t])

D[LU[pi[t], pit[t], ygap[t], pie, a, b, c, lm[t], cr, st], pi[t]]
=>
lm[t] + 2 b (-pie + pi[t]) + 2 a (pi[t] - pit[t])

D[LU[pi[t], pit[t], ygap[t], pie, a, b, c, lm[t], cr, st], lm[t]]
=>
-(1 - cr) pi[-1 + t] + pi[t] - cr pit[t] - st ygap[t]
```

Simplifying the system:

```
Solve[{-st lm[t] + 2 c ygap[t] ==
   0, -cr lm[t] - 2 a (pi[t] - pit[t]) == 0,
  lm[t] + 2 b (-pie + pi[t]) + 2 a (pi[t] - pit[t]) ==
   0, -(1 - cr) pi[-1 + t] + pi[t] - cr pit[t] - st ygap[t] - e[t] ==
   0}, {pit[t], ygap[t], pi[t], lm[t]}]
=>
{{ygap[t] -> -((
    st (-a b pie + a b cr pie + a b e[t] + a b pi[-1 + t] -
       a b cr pi[-1 + t]))/(
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2)),
  pit[t] -> -((-b c cr pie - a b pie st^2 - a c e[t] + a c cr e[t] +
     b c cr e[t] - a c pi[-1 + t] + 2 a c cr pi[-1 + t] +
     b c cr pi[-1 + t] - a c cr^2 pi[-1 + t] - b c cr^2 pi[-1 + t])/(
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2)),
  pi[t] -> -((-b c cr^2 pie - a b pie st^2 - a c e[t] + a c cr e[t] -
     a c pi[-1 + t] + 2 a c cr pi[-1 + t] - a c cr^2 pi[-1 + t])/(
```

```
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2)),
  lm[t] -> -((
    2 (-a b c pie + a b c cr pie + a b c e[t] + a b c pi[-1 + t] -
       a b c cr pi[-1 + t]))/(
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2))}}

Solving the system of recurrence equations:

RSolve[{ygap[t] == -((
    st (-a b pie + a b cr pie + a b pi[-1 + t] - a b cr pi[-1 + t]))/(
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2)),
  pi[t] == -((-b c cr^2 pie - a b pie st^2 - a c pi[-1 + t] +
     2 a c cr pi[-1 + t] - a c cr^2 pi[-1 + t])/(
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2)),
  pit[t] == -((-b c cr pie - a b pie st^2 - a c pi[-1 + t] +
     2 a c cr pi[-1 + t] + b c cr pi[-1 + t] - a c cr^2 pi[-1 + t] -
     b c cr^2 pi[-1 + t])/(
    a c - 2 a c cr + a c cr^2 + b c cr^2 + a b st^2)),
  ygap[0] == ygap0, pi[0] == pi0, pit[0] == 0 }, {pi[t], ygap[t],
  pit[t]}, t]
=>
{{ygap[t] ->
   1/(c (-1 + cr)) (b c cr^2 +
       a (c (-1 + cr)^2 + b st^2))^-t (-c (b c cr^2 +
          a (c (-1 + cr)^2 + b st^2))^t ygap0 KroneckerDelta[t] +
       c cr (b c cr^2 + a (c (-1 + cr)^2 + b st^2))^
        t ygap0 KroneckerDelta[t] +
       b (a c (-1 + cr)^2)^t pi0 st UnitStep[-1 + t] -
       b (a c (-1 + cr)^2)^t pie st UnitStep[-1 + t]),
  pi[t] -> (b c cr^2 +
      a (c (-1 + cr)^2 + b st^2))^-t ((a c (-1 + cr)^2)^
       t pi0 - (a c (-1 + cr)^2)^t pie +
      pie (b c cr^2 + a (c (-1 + cr)^2 + b st^2))^t),
  pit[t] -> -1/(
     a (-1 + cr)) (b c cr^2 +
        a (c (-1 + cr)^2 + b st^2))^-t (a pie (b c cr^2 +
           a (c (-1 + cr)^2 + b st^2))^t -
        a cr pie (b c cr^2 + a (c (-1 + cr)^2 + b st^2))^t -
        a pie (b c cr^2 + a (c (-1 + cr)^2 + b st^2))^
         t KroneckerDelta[t] +
        a cr pie (b c cr^2 + a (c (-1 + cr)^2 + b st^2))^
         t KroneckerDelta[t] +
        a (a c (-1 + cr)^2)^t pi0 UnitStep[-1 + t] -
```

```
        a (a c (-1 + cr)^2)^t cr pi0 UnitStep[-1 + t] -
        b (a c (-1 + cr)^2)^t cr pi0 UnitStep[-1 + t] -
        a (a c (-1 + cr)^2)^t pie UnitStep[-1 + t] +
        a (a c (-1 + cr)^2)^t cr pie UnitStep[-1 + t] +
        b (a c (-1 + cr)^2)^t cr pie UnitStep[-1 + t])}}
```

Visualization code and alternative specifications available upon request.

Chapter 2

Perspectives of Inflation Targeting: Will We Survive the Turmoil?

2.1 Introduction

During the current financial crisis we have heard many opinions on the conduct of monetary policy. What went wrong in the past, what could be done now to help the economy, what should be changed to prevent similar breakdown in the future. In this essay we will try to asses perspectives of particular monetary policy regime, which became increasingly popular among both developed and emerging market economies: inflation targeting.

Inflation targeting was pioneered by the Royal Bank of New Zealand in 1989. The regime, where a credible nominal anchor of inflation target is meant to drive inflation expectations to the desired inflation rate was developed as a tool to reduce high inflation rates in the late 80's and early 90's. In the first cases of New Zealand and Canada, IT was developed virtually overnight as a policy framework which could replace badly performing monetary targeting. During the 90's, many other central banks adopted inflation targeting, both from developed and emerging market economies. For example, UK introduced IT regime soon after collapse of ERM (exchange rate targeting regime) in 1992. It is characteristic that in the first IT countries the framework was adopted with little academic discussion behind, the theory came first during 90's (Svensson (1998)). This also points out the practical nature of inflation targeting, which was developed as an ad-hoc measure to replace badly performing earlier monetary policy regimes.

Like other monetary policy regimes, the ultimate final goal is to stabilize price level (or inflation, as price level growth). The difference is, however, in the intermediate "state variable". In case of exchange rate peg regime, exchange rate plays the role of intermediate target, and it is believed that holding exchange rate stable helps to achieve price stability. This may hold to some extent, mainly in small open economies where prices are to a large extent imported. In monetary targeting regime, money supply is used as an intermediate target. Again, it is believed that dynamics of money aggregates determine inflation.

In case of inflation targeting, the major role of intermediate target is played by inflation

forecast and inflation expectations (which is supposed to be the same). What is targeted is the forecast of inflation. Common belief is that price- and wage- setters set prices and wages in accordance to the expectations and thereby help the central bank to make the forecast come true. Success of anchoring inflation expectations is conditioned on proper communication and transparency. It is therefore not surprising that inflation targeting central banks were leaders in transparency and general opening to public.

In addition to the "inflation expectations management" inflation targeting involves strong commitment of central bank to conduct monetary policy (drive the control variable of short term interest rate) in a best way to fulfill both intermediate and consequently also ultimate target.

Compared to other monetary policy strategies, inflation targeting (which is, for reasons mentioned above, sometimes called inflation *forecast* targeting) uses variety of available information in the decision process. If a central bank was targeting exchange rate, it would have to rise interest rates whenever exchange rate falls (see Fisher parity equation). If it was targeting monetary aggregates (say M1), it would have to rise interest rates whenever M1 grows too fast. In other words, these two mentioned monetary policy strategies put ultimate weight on information carried by exchange rate and M1, respectively, and suppose that these are good proxies for future inflation. On the contrary, inflation targeting relies on inflation forecast. This forecast can (and must, to get on the effectiveness frontier) include all available information. The core of the forecast is usually made by a macroeconometric model (either DSGE or VAR), which includes only some of the available data. However, forecasts do not typically rely only on the model output, but are further fine-tuned using expert judgement, alternative scenarios are considered and possible risks are carefully assessed. The resulting mean inflation forecast is then targeted. It could thus be argued that inflation targeting takes into account all available information.

Relying on inflation forecast imposes some requirements on inflation targeting central banks. First, it is a considerably know-how intensive monetary policy regime as detailed and robust high-quality forecasts are needed. The forecasts should incorporate up-to-date economic research, not to lag behind in either methodology or particular macroeconomic relationships. Central bank has to be able to handle this. Moreover, the data needed for construction of the model should be of adequate quality, posing further requirements on statistical office and length of applicable time-series. However, as we will further discuss, these conditions do not need to hold strictly, as suggested by considerable success of inflation targeting in emerging market economies.

To sum up, we use Svensson's definition of inflation targeting:

- explicit numerical inflation target
- ...that is pursued in the medium run to avoid real instability (for instance in the output gap)
- which makes inflation targeting to be "flexible" rather than "strict"
- and due to the unavoidable lags in the effects of instruments on inflation, the decision framework is in practice "inflation-forecast targeting"

- in addition, communication is very explicit ...

- and policy decisions are consistently motivated with reference to published inflation and output (-gap) forecast

2.2 Inflation Targeting: A Story of Success?

2.2.1 Rules Versus Discretion Debate

During last three decades, monetary theorists and policymakers lead a prolonged debate whether monetary policy should be conducted with discretion or under a rule.

Common logic would imply that discretion in any optimization problem weakly dominates rule. The reason is that optimization under discretion could take into account all available information up to the moment of decision, contrary to any rule which was set in the beginning of the game, without knowledge of latest development. Moreover, if the decision implied by the rule was still optimal given all available information, an agent optimizing under discretion would always be able to replicate the choice. Therefore, optimization under discretion is at least as effective as under rule.

However, the time-inconsistency problem first presented by Kydland and Prescott in their seminal work "Rules Rather than Discretion: The Inconsistency of Optimal Plans" (1977) showed that discretion could lead to socially suboptimal outcomes. Policymakers tend to change their optimal plans from what was promised and increase inflation to exploit the Phillips curve relationship. Output gap rises, but consequently also inflation expectations rise and shift the whole Phillips curve, which pushes output gap back to equilibrium. The resulting steady state is far from social optimum and even policymakers' utility is lower compared to the starting point. Numerous discussions were held to find a solution to the time-inconsistency problem. As a result we have independent central banks and clear mandate for price stability in most cases (with a notable exemption of Federal Reserve having dual mandate).

Inflation targeting seems to hold the flag of the "rules" side nowadays. Not only it imposes simple mandate for the central bank (fulfilling the inflation target), but moreover it is close to the "optimal contract for central banker" proposed by Walsh. Reserve Bank of New Zealand, the first and still one of the most orthodox inflation targeters, really does use option of firing governor in case of missing the target without reasonable explanation.

Still, inflation targeting should not be viewed as a strictly mechanistic rule. The discretion plays important role in the decision process. The whole inflation forecast, which is in fact the targeted intermediate variable, is a result of design of the main forecasting model, other models taken into account and finally an expert judgement about future inflation path. Further, understanding transmission mechanism of the economy is crucial element in inflation targeting, and often differs even among members of a bank board. Magnitude and even direction of control short-term interest rate change is subject to elaborate discussions on the bank board meetings in both IT and non-IT countries. All these elements signal

presence of discretion in otherwise rule-based inflation targeting. Most accurately we could talk about rule-based discretion.

The time-inconsistency and rules versus discretion debate would seem to be resolved by inflation targeting, if only did the most prominent central banks in the world, the Federal Reserve and European Central Bank, use other policy regimes. Most probably they are not pursuing sub-optimal policies, so what makes them reject the "best practice" framework?

2.2.2 Account of Inflation Targeting: Survey of Literature

How do inflation targeting countries perform compared to the non-targeting ones? There has been many papers written on this topic. Some of them (Walsh (2008)) argue that inflation targeting is a successful policy regime, as it delivered price stability with no adverse effects on real volatility, as expected by critics. Inflation targeting is focused on minimizing inflation volatility. Based on the Phillips curve inflation-output trade-off, critics of inflation targeting argue that stabilizing inflation would result in more volatile output.

Mishkin and Schmidt-Hebbel (2006) and Walsh (2008) and many others conclude that no such adverse effects on output volatility were observed.

But did inflation targeting perform strictly better than other policy regimes? It is apparently difficult to find evidence in favor of strictly better performance of inflation targeting in developed countries. The cited Mishkin and Schmidt-Hebbel (2006) paper does not find that developed inflation targeters have performed better compared to developed non-targeters. However, the benefits are more visible in case of emerging market inflation targeters, which were able to significantly narrow the gap between developing and developed economies.

Analogous conclusion is made by Lin and Ye (2007a, 2007b). In their first paper (Lin and Ye (2007a)) they use a sample of 7 developed countries and based on propensity score matching methods conclude that inflation targeting has no significant effect on either level or variability of inflation. In the second paper (Lin and Ye (2007b)) they use another sample of 13 developing countries and using similar methods conclude that inflation targeting significantly lowers both mean and variability of inflation. Inflation targeting seems bring more benefits in emerging economies than in developed ones.

Batini and Laxton (2006) evaluate the performance of inflation targeting in emerging market economies and discuss conditions needed for a country to successfully pursue IT. Focus on developing countries brings results strictly in favor of inflation targeting: compared to other monetary policy regimes, IT scores better in both inflation and inflation expectations while no adverse effects on output are observed. Moreover, Batini and Laxton (2006) observe less volatility in interest rates, exchange rates and FX reserves and lower risk of currency crises in IT developing countries. Surprisingly, exchange rate pegs are dominated by IT even in these criteria. The conclusion is that emerging economies do not need to wait to meet the stringent criteria for IT adoption and that adoption of IT will lead to surplus with any starting conditions.

Jonas and Mishkin (2005) also conclude that inflation targeting has been successful framework in developing countries. They stress avoiding target undershooting and parallel

exchange rate targeting, which may damage fragile credibility of the regime in emerging economies. EME's face more severe shocks and more painful trade-off in inflation and output than developed countries, which, however, does not imply that other monetary regimes are superior to IT. Same observation is made in Fraga, Goldfajn and Minella (2003).

Caballero and Krishnamurthy (2005) stress an important role which inflation targeting could play in overcoming "fear of floating" in developing countries. By commitment to inflation target central banks are less tempted to "protect" currency in short run fluctuations.

Recent paper by Siklos and Weymark (2009) compares monetary policy performance of developed countries using constructed indicator of "inflation pressure": Australia, Canada and New Zealand are compared with non-targeting United States. They conclude that inflation targeting countries are under substantially lower inflation pressure and that less movement in interest rates is needed to stabilize the price level.

Among other IT optimists, Vega and Winkelried (2005) conclude that "Inflation targeting has helped in reducing the level and volatility of inflation in countries that adopted it", using propensity score matching method. They enjoy the "natural experiment" characteristic of the IT evaluation problem and test robustness of their results on various control groups of both IT-ers and non-IT-ers.

Wu (2004) examines whether IT's observed impact on inflation is not only a result of more strict and conservative monetary policy. He finds that interest rates have not been systematically higher in IT countries. Moreover, even when interest rate movements are controlled for, adoption of inflation targeting has significant impact on inflation. Lower inflation is therefore not an effect of more aggressive policy of inflation targeters.

Feasibility of inflation targeting for the United Stated is discussed in Rudebusch and Walsh (1998) and more recently in Goodfriend (2005). Both papers realize that the Federal Reserve is in fact pursuing inflation targeting in an implicit form. Whether explicit IT would help the Fed in achieving the target is not clear to Rudebusch and Walsh (1998) as similar record of inflation development was observed in both IT and non-IT during the 90's. Goodfriend recommends IT for Fed and stresses role of Congress, to which Fed could be accountable of meeting the agreed target.

Similar issue is adressed by Tempelman (2008), who conludes that "Because the 1 to 2 percent long-run [inflation] comfort zone of implicit inflation targeting is so universally understood to be the Federal Reserve's existing practice, it is not clear what is to be gained from explicit announcement", which we leave without comment.

"A view from ECB" is presented by Issing (2003). Issing realizes, that there is not much difference in actual policy conduct between countries labeled as "inflation targeters" and others. No central does the orthodox inflation targeting, a degree of flexibility is present in each country. ECB, Fed and inflation targeting central banks were all successful in anchoring inflation expectations and reduced inflation volatility, which are the most commonly mentioned benefits of IT.

Inflation targeting is viewed as an emerging new international monetary policy paradigm in Rose (2006). Independent central banks, no restrictions on capital mobility, exchange

rate float, but in the end also low exchange rate volatility. Domestic focus, no "big plans" not relying on international coordination, no role for central country, for gold, no IMF-like institution. Durable regime, no IT crisis and abandonment observed so far. Rose (2006) concludes: "Inflation targeting is Bretton Woods, reversed."

Stiglitz (2008) presents diametrically opposite view: "Today, inflation targeting is being put to a test - and it will most certainly fail." Stiglitz criticizes myopic policy reactions to imported inflation coupled with inability of small open economies' monetary policy to influence world prices (illustrated on example of 2007/2008 world oil and food price inflation).

Other famous argument against IT is derived from work of Ball and Sheridan (2005). In their paper they survey developed countries, both IT and non-IT. They find that inflation targeting does not help to achieve significantly better outcomes. A similar conclusion that inflation targeting does not matter is made by Willard (2006). Contrary to the latter paper, Ball and Sheridan (2005) acknowledge that inflation targeting transparency and accountability are "consistent with principles of democratic society" more than the "Just do it" way of conducting monetary policy.

Ravenna (2007) tests the "luck hypothesis" saying that success of inflation targeting in Canada would be replicated even without IT in place. He finds that similar results would be achieved with 35% probability under status quo policy. He concludes that performance of IT has not been extraordinary so far, maybe because it has not been put to test by severe inflationary shocks yet.

Roger and Stone (2005) point out that inflation targets have been missed in 40% of time in the IT countres, while the misses have been often severe and prolonged. A question then arises, why did the central banks did not abandon the regime, why no "inflation targeting crisis" occured due to these misses? Flexibility of inflation targeting, high standards of transparency and accountability and lack of viable alternatives are presented as answers.

Importance of transparency is stressed by several other studies: Little and Romano (2009) subscribe the IT's ability to anchor expectations to stress it puts on improving transparency, which is in fact available to all central banks, not only to the inflation targeting ones. Sims (2005) argues that inflation targeting does not cope with the most painful problems associated with inflation: deflation traps, hyper-inflationary spirals and fiscal dominance. With lack of coordination with fiscal policy inflation targeting is powerless. Any inflation target is not credible unless fiscal policy commits to cooperate on it. However, a significant improvement in transparency is acknowledged. But, as mentioned above, any central bank could be transparent, IT or not. Loayza and Soto (2002) also find transparency and effective communication as a crucial asset of inflation targeting framework, and the most important "best practice" spillover to other monetary policy regimes.

There are even a few critics of inflation targeting communication: Faust and Henderson (2004) point out the contradiction between commonly agreed preference function of a central bank, which is concerned not only about inflation but also about the output gap, with the declared mandate which solely focuses on maintaining price stability. Why do central bankers not admit that they are "flexible inflation targeters" (concerned also about

output gap) and pretend to be "strict inflation targeters"? And even if they admit it, what is the output level they target? Apparently, only a half of the story is being communicated to the public.

Finally, Woodford (2003) does not find inflation targeting as fully optimal policy, as it does focus on inflation forecast only in the medium-term. The nearer-term price level path is then left unanchored. A more elaborate framework is needed to conduct optimal policy even in the nearer-than-medium-term.

We have seen that there are many opinions on inflation targeting in the literature. Lot of researchers did find that inflation targeting improves economic performance, lot of them found that not. Overall impression is that developing countries are able to gain more from potential benefits of the framework, maybe because industrialized countries like the U.S. and Eurozone members are already close to the monetary policy effectiveness frontier.

A particularly strong result is that no empirical study did find any adverse effects of inflation targeting. Moreover, no country did abandon IT due to "inflation targeting crisis" (only Finland and Spain left the club while entering the Eurozone).

So far so good, but what are the future prospects of inflation targeting? Should we fear with Stiglitz that inflation targeting will damage the ability to recover from the 2008/2009 financial turmoil and subsequent real crisis?

Mervyn King (2005) asks "how serious are the problems posed by issues as asset price inflation?" Was his humble remark back in 2005 not a strike home, considering developments in last years?

2.3 Facing the Financial Crisis

How does inflation targeting score in the turmoil of 2008/2009 financial crisis and subsequent worldwide real decline? Were the fears of above cited commentators relevant for current development, did the critics foresee the problems we are now facing? Is inflation targeting in fact facing any problems? What is the role of inflation targeting in the crisis, is it a burden or a lighthouse to guide monetary policy in the blizzard? Should we now reconsider the arguments pro and contra inflation targeting?

2.3.1 Rigidity?

One of the often mentioned criticisms of inflation targeting framework goes along the line of policy rigidity. The early IT critics claim, that inflation targeting focuses too much on inflation, that it is not flexible enough. "Inflation nutters" are willing to sacrifice large proportions of output by cutting interest rates to succesfully disinflate. However, many others argue that all inflation targeters are to some extent flexible and no central bank is a "strict inflation targeter". Issing (2003) mitigates the differences among ECB, Fed and IT central banks in how they in the end conduct monetary policy.

Still, this argument may be of some relevance, when we realize that most central banks did hold interest rates at relatively high levels up to 10/2008, fearing that the world food

and oil price shock may persist. (ECB 4.25%, BoE 5.0%, Riksbank 4.75%, CNB 3.5%, most of which were the peak values of monetary restriction) As research on monetary transmission mechanism suggests, actions of monetary policy take largest effects with a lag of 12-16 months. The monetary tightening pursued by central banks worldwide will therefore strike the economies with the most power at the end of 2009, when the price shocks of 2007/2008 will be gone for long. To the contrary, economy of U.K. fell into deflation (-0.4%) measured by RPI in 3/2009, as well as the U.S. (-0.38%) measured by CPI and other countries on the edge.

However, it is not clear if countercyclical policy should be subscribed to too much focus on inflation. Deflation is definitely not something which even "inflation freaking" central bankers would be happy with. And importantly, all the central banks kept the rates high, both inflation targeting and others.

2.3.2 Too Narrow Focus?

Maybe the most severe objection which appeared since the crisis breakout is too narrow focus of monetary policy, inflation targeting before all. The ultimate goal of monetary policy is price stability in most cases. Price level is, however, usually measured by some kind of price index, which takes into account necessarily a limited number of goods. What is being targeted in most central banks is inflation measured by core CPI (Canada, Australia), headline CPI (UK, Sweden) or a closely related measure (RPIX: UK before 2004, PCE: non-targeting US).

CPI, even when the headline version is considered, does include prices weighted by their importance in a consumer basket. The consumer basket composition is typically based on statistical surveys. It does not contain (or does, but with a low weight on final index) variety of non-consumer prices, which are, however, crucial for the economy while considering for example investment decisions or credit collateral.

This shortcoming has shown up particularly painful at the outset of current financial crisis: asset prices were growing fast (asset price inflation) and created the nowadays thoroughly discussed bubbles. Especially housing prices played significant role in this process and stayed to a large extent unreflected in the consumer price indices and thus also by monetary policy. Although there was enormous inflation on housing market, the Federal Reserve (although not inflation targeting) kept low interest rates as CPI inflation risks were low, thereby fueling further investment in housing and further inflating the bubble.

An important question arises, if central banks should to some extent broaden their definition of inflation to capture also other assets than those included in CPI basket. Some non-consumer assets have significant impact on the balance sheets of financial institutions and values of collateral. Credit availability is therefore also influenced and the overall wealth of financial agents is at stake, as was many times observed during the 2008/2009 crisis.

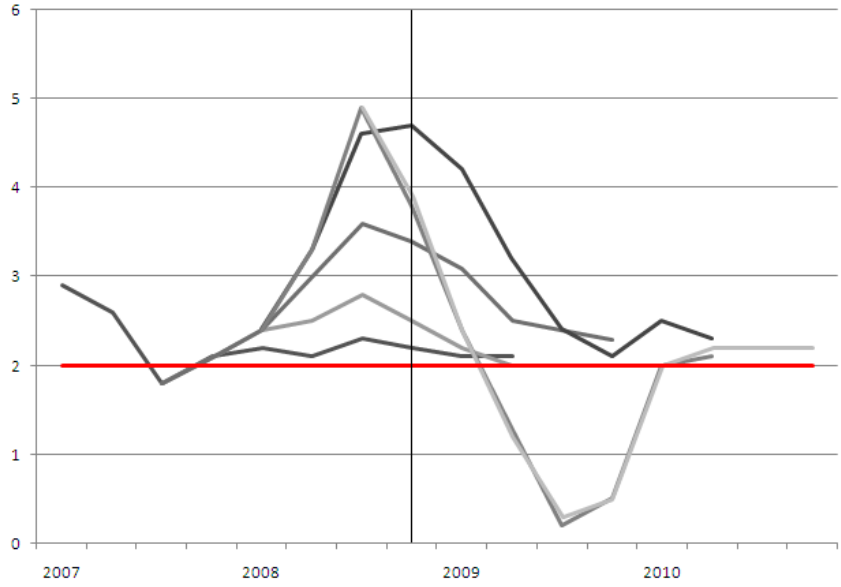
Some commentators suggest that central bank should "lean against the wind" with a restrictive monetary stance when an asset bubble threatens to emerge. However, it would

be no more an exceptional "leaning" (distinct from the pure inflation targeting) when the prices which create the bubble would be incorporated into the target itself. Such alternative broad definition of inflation target would definitely need much more research on transmission mechanism from control short term interest rate to the new definition of price level.

2.3.3 Irrelevance of Forecasts and Communication Issues

Inflation targeting relies to a large extent on forecasts. What is being targeted is in fact the inflation forecast itself. What is then to be targeted in situation when any forecast is unreliable, such as in the second half of 2008? Inflation forecast tergeters are clearly first to be affected by the forecast inaccuracy. Given the development in early 2009, the term "inaccuracy" becomes weak for what we observe. More likely the forecasters and analysts are facing uncertainty of Knightian type. Not even that simple additive shocks and stochastic parameters of the model have increasing variance, moreover we can not believe the model itself.

Figure 2.1: CPI Inflation Consensus Forecasts for UK



The Figure 2.1 shows Consensus forecasts of CPI inflation in UK. Even in such a developed country with long time series and robust forecasting framework, relying on forecasts may lead even to pro-cyclical monetary policy. Forecasts for second half of 2009 have predicted CPI inflation above inflation target, and the monetary tightening policy pursued given that forecast would in the end only deepen the emerging unexpected deflation.

Admitting such degree of uncertainty the inflation targeting banks might suffer large credibility losses. On the other hand, issuing forecasts out of reality does not help credibility either. How to tackle this Skylla and Charybdis?

Most commentators above acknowledge, that one of the main uncontroversial contributions inflation targeting has brought is increased focus on transparency. Most likely, central banks would do best by communicating the perceived risks, by further revealing secrets (and also uncertainties) of the temple, by sharing the know-how of policymaking with public. Inflation targeting should not, and hopefully would not, abandon the most significant benefit it brought to monetary policy in general: new standard in best practice of central bank communication and transparency.

2.3.4 Monetary Policy Inefficiency and Target Credibility

Another issue that is being discussed nowadays is credibility of inflation target facing borders of monetary policy. In the deflation periods the central bank is virtually unable to move along the Phillips curve. Inflating the economy using monetary easing is simply not possible due to zero bound on nominal interest rates. Another problem limiting the monetary policy effectiveness emerged during the 2008/2009 crisis: increased gap between control short-term policy rate and the long term interbank interest rates. When the previously close relationship starts to be loose, monetary policy is unable to influence the effective interest rates in the economy. In both cases monetary policy becomes impotent.

Monetary policy inefficiency undermines credibility of inflation target: when the bank can not commit to fulfillment of the target because of monetary policy boundaries, it is no more rational for the agents to follow the target inflation rate in their price- and wage-setting decisions and inflation expectations start to diverge. As proposed by Sims (2005), inflation targeting would not be fully credible unless fiscal policy will be committed to cooperate. This might be one of the possible ways out of the target credibility puzzle. Another one might be preventive communication policy. If the central bank could manage inflation expectations not to fall to negative numbers, deflation would be only a transitional state. This is a serious challenge for central banks' monetary policy communication today.

2.4 Conclusion

In the first section we have surveyed the state-of-art literature evaluating the policy framework of inflation targeting. Some authors do find significant benefits of inflation targeting framework, some do not. The benefits of IT are apparently larger in emerging market economies than in the developed ones. The emerging countries probably more benefit from strong nominal anchor, increased credibility and self-disciplining rules, while the developed ones could reach all these even without inflation targeting framework.

Although the opinions on IT vary, common conclusion is that inflation targeting *does not harm* the economy. Moreover, no inflation targeting crisis was observed the the 20-years history of the framework.

The most often acknowledged benefit of inflation targeting is increased focus on communication and transparency. However, many commentators argue that similar communication best-practices could be pursued by any central bank, inflation targeting of not.

In the second section we have assessed the future perspectives of inflation targeting, especially facing the current 2008/2009 crisis. Among the issue open to dispute we see the definition of inflation target itself. Is the CPI (and related measures) not too narrow for stabilization policies? Other assets, mainly of financial and real-estate nature could be included into the measures to control for extraordinary inflation of asset bubbles. Clearly, more research would be needed to describe the transmission mechanism from control short term interest rate to asset and household prices, in both quantitative and time dimension.

Rigidity of inflation targeting regime plays prominent role in argumentation of it's critics. However, along with several authors we conclude that inflation targeters are rather flexible than strict and that inflation targeting is not characterized by more aggressive policy reactions. However, inflation targeting could have contributed to the prolonged monetary tightening up to 10/2008, which contributes to the 2009 real recessions and deflation threats.

Another issue is the IT's reliance on forecasts, coupled with the forecast unreliability during the turmoil. Still, the conclusion is that inflation targeting central banks should stick to their best practice of communication and transparency and present the perceived risks and uncertainties to the public. Admitting a degree of uncertainty would harm credibility of both the IT framework and the institution less than self-confident presentation of wrong forecasts.

Last discussed problem is credibility of inflation targets faced with monetary policy inefficiency in extreme cases of deflation or high risk premiums on the interbank market. One of the proposed solutions is credible commitment of fiscal policy to cooperate, another might be preventive communication strategies which would not let the inflation expectations to diverge.

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